PLEASE SEE PAGES 7, 13 and 35 for IMPORTANT WARNINGS and DISCLAIMER

This document is

A Written Supplement to the Video

"Bill Webb's Barrel Making Machine with Bill Webb and Guy Lautard"

September 1995

from Barefoot Video Productions

NOTE

This video was shot at the home of Bill Webb in Kansas City, Missouri, in May, 1995. It shows construction and operating details of a self-contained machine suitable for making rifle barrels for yourself and friends. As Bill mentions in his initial comments, a machine like his is not suitable for commercial barrel making - it is simply too slow for that. But it is well adapted for making barrels for your own use.

The machine will drill, ream and rifle a barrel from the solid bar. If you build one, and learn the necessary skills, you should be able to make match grade benchrest barrels on it.

Careful study of the video and this written supplement which accompanies it should enable any interested machinist to build a similar machine, incorporating certain significant improvements that Bill will point out.

Throughout this document, where reference is made to direction, e.g. *"... at the right hand end of the machine.."* - the reader is at that moment assumed to be located as he would be if operating a metal lathe - headstock on his left, tailstock on his right; the front of the machine is where the lathe cross slide crank would be (in front of his belly button), and so on. GBL

(Most of what follows is taken from - or adapted from - letters from Bill Webb to Guy Lautard.)

INTRODUCTION

I was never that interested in making rifle barrels of any kind. My Dad, on the other hand, was obsessed with the idea for as long as I can remember. In 1972 we designed and built a reaming and rifling machine. Dad built 90% of the machine in his small shop in Macks Creek, MO, using only a 9" South Bend lathe and a small horizontal mill - old, but accurate. We were planning to rebore only, so that first machine did not include drilling capabilities. Slowly, my interest was piqued and I became involved up to my ears.

In 1982 I designed and built, in my shop in Kansas City, a second machine, which is the one shown in the video. The main difference over the earlier machine is that it has deep hole drilling capabilities. I had nothing to base the drilling portion of the design on except basic speed and feed information.

As in most "original" designs by amateurs, it is similar to a number of other basement rifling machines that have been built over the years all over the US. (I have learned of several since making this one. I know of one built in the late 1950's that has passed through 4 owners and has produced record-setting benchrest barrels.) Expediency

dictates, and the design is influenced primarily by shop limitations and material availability.

Although compact and simple in design, my machine - and others like it - are capable of turning out match grade barrels second to none. The secret lies in patience, good workmanship, and razor sharp tools. As ye sow, so shall ye reap ... especially in cutting good rifle barrels!!

However, Dad and I didn't progress quite that fast! We soon found out that making the machine was the easy part. When we followed the information in available gunsmithing books, we found that cutting grooves in reamed bores was a nearly impossible task. After about 2 and a half years of frustration, we decided that most of these books were full of beans, and started using common sense!! Much time could have been saved if we had started out this way. There is no magic involved, just good metal cutting practice!

We developed a rifling head that is a modified form of the conventional ramp adjusted head. The front of the rifling cutter is anchored in its slot in the rifling head body with a cross pin, and spring loaded to hold firmly against a movable adjusting ramp. This method of holding the cutter saves a lot of headaches common to what we later learned to be a conventional cutter head.

I have no idea how the procedures my Dad and I developed compare with other people's methods. Their methods may or may not resemble those described here. I don't profess to be "a barrel maker," and certainly not a professional one - I'm just an amateur experimenter. I haven't made enough barrels to even begin to know all the answers.

If a barrel shoots well, it is not because there is any magic involved. Straightness, uniformity of twist rate, surface finish, bore and groove size uniformity are all important to making a match grade barrel. Although controversial, it is my belief that a well made cut rifled barrel has an advantage over its button rifled counterpart, in terms of uniformity of twist and the absence of significant residual stress, especially if - as is common - the OD of each were to be turned to a long taper after rifling.

Any average basement machinist who has the motivation to master the matter of barrel making should be able to do so. The learning curve may be somewhat long and bumpy for someone not familiar with the feel of the rifling head in cut. However, most of the basics will be found in this video, and should smooth out the road considerably. If a person is willing to take the time and pains to do certain tasks properly, and to pay attention to details, he can expect success, providing he does not become frustrated and give up before obtaining satisfactory results.

(As a Russian astronaut - who must have been a poet - once said, "The road to the stars is steep and difficult." GBL

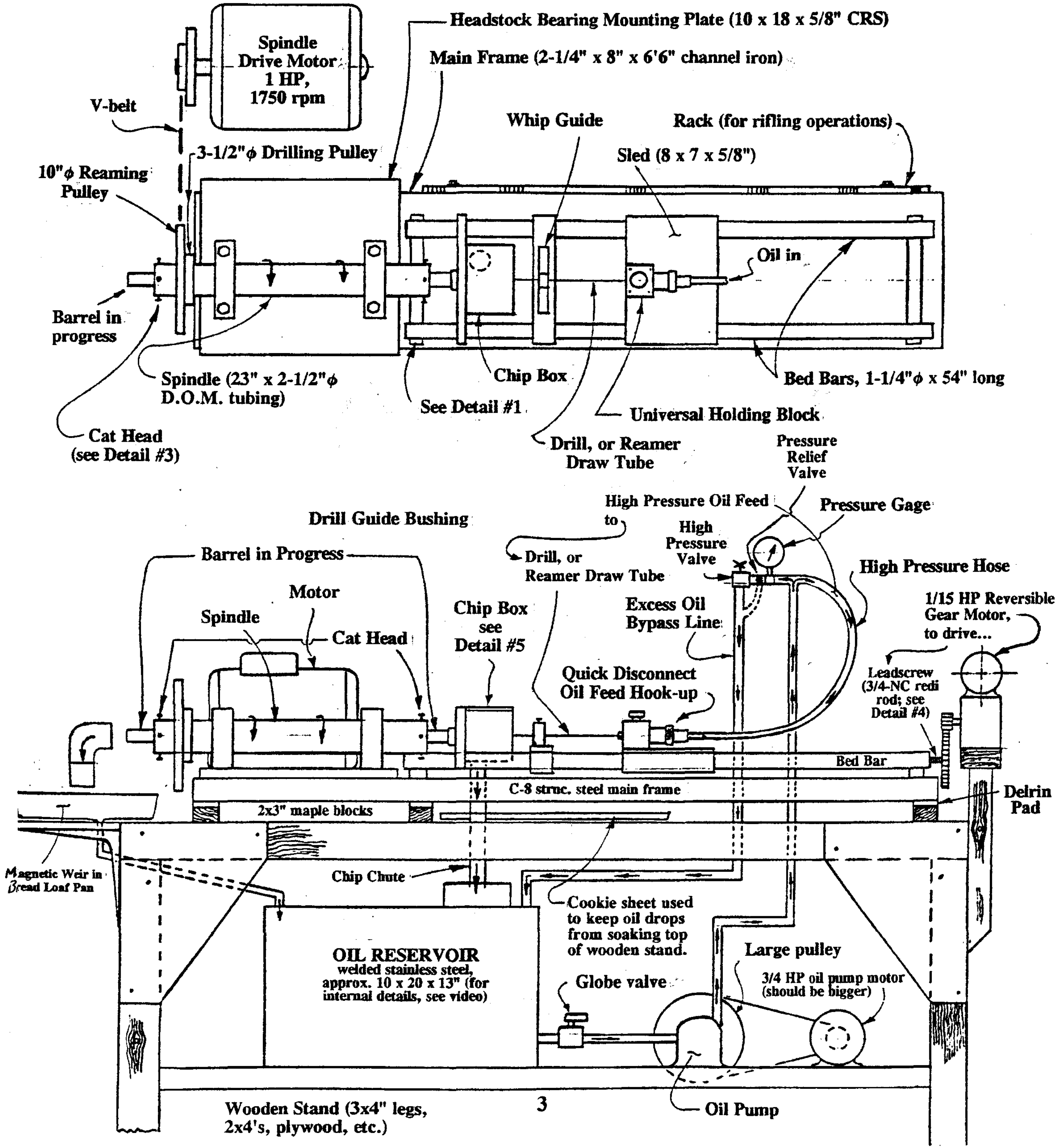
OVERALL DESCRIPTION of the DRILLING, REAMING, AND RIFLING MACHINE

Our second rifling machine - the one shown in the video - was not designed for production, or even as a permanent piece of equipment. It was primarily used for experimental tinkering and to produce a few barrels for our own use. It was designed,

text continues at page 4

GENERAL ARRANGEMENT DRAWING
of
the Webb Rifling Machine

(NOTE: Shown in Drill & Ream Configuration. Parts involved in use as a rifling machine are NOT shown on this drawing.)



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built, and drilling its first hole in six weeks. The cost was minimal, and most of the material came from the scrap yard. In fact, the design was somewhat dictated by this consideration.

The machine rests on a wooden bench 74" x 15" wide. It is not attached to this bench in any way. The machine base (or main frame) is a 74" long piece of 8" x 2-1/4" structural channel iron, commonly known as "C-8". This sits with the open side "down," in grooves cut in Delrin plates which are epoxied to maple support blocks.

The Spindle assembly is attached to a 5/8" x 10" x 18" CRS plate which is bolted to the solid side of the inverted channel. The Spindle bearings are self-aligning ball bearings (Sealmaster NP39, 2-7/16" ID) bolted directly to the mounting plate.

> When I got home from the trip to Kansas City, I inquired at a local bearing supply house as to the type and approximate cost of a pair of bearings like the ones Bill used. Apparently they are "standard duty single row pillow block ball bearings." (Bill says on the video that they may be *double row* bearings, but that is not the case.) Cost would be on the order of $100 for a pair, so this is certainly livable, even if you had to buy new. Bill and I both thought they would be quite a bit more expensive than this at the time we shot the video.
>
> Another point that came to light later was the fact that this particular type of bearing (Sealmaster NP39), which is grease fed, is the correct type to use in an application like this, where oil or swarf could contaminate the bearing. A greased bearing allows the operator to purge the bearing at any time by pumping in fresh grease.
>
> However, do note that such greasing can easily be overdone - the addition of small amounts of grease at regular intervals is much better than pumping in a big wad once in a blue moon. Over-greasing - where you do not get out an amount of grease equal to that pumped in, can in itself be quite destructive to such a bearing, in addition to adding significant drag. This might be a problem if one were using a marginally adequate drive motor. GBL

The Spindle itself is a 23" long piece of 2-1/2"OD x 1-1/2"ID D.O.M. (drawn over mandrel) tubing turned to fit the 2-7/16" ID bearings. Mounted at the far left end of the Spindle is a 10-1/4" x 3/4" aluminum pulley grooved for a 1/2" V-belt. This is the reaming pulley.* A 3-1/2"ϕ steel pulley lies between the reaming pulley and the rear bearing, and gives a much higher spindle speed for the drilling operation. The V-belt used is simply a standard V-belt.

> * Bill made the reaming pulley that he has on his machine, but a pulley of this size (or very close to it) can be bought as a stock item at a bearing supply house. GBL

At each end of the Spindle, four 3/8-24 x 1-1/4" bolts form a cat-head type "chuck" for securing and centering the barrel blank.

> These bolts should all be fairly tight while centering the barrel blank. On Bill's machine, each Cat Head bolt carries a nut that one could tighten down as a lock nut once he had his barrel centered to his satisfaction, but Bill says he doesn't always do this himself. He also notes that if you tighten the lock nuts heavily after centering the barrel blank, and then re-indicate, you'll likely find that your oh-so-careful barrel centering operation has gone out the window. If the lock

nuts are made finger tight only, they do not disturb your careful centering job - but in that case they probably don't have much effect as "lock nuts" either. Personally, I'd be somewhat inclined to leave them off entirely. GBL

See also Detail #3 at page 7 herein for an IMPORTANT SAFETY CHANGE RECOMMENDATION involving the use of socket head set screws instead of hex head bolts. GBL

Suggested Improvement

The collar seen around the middle of the Spindle (and not shown in any of my drwgs GBL) is for indexing the Spindle/barrel blank during rifling, and locks with a plunger and cam lock. Holes are available for 2, 3, 4, 5, 6, and 8 grooves.

The Spindle is turned by a 1 HP, capacitor start, 1750 RPM motor, which is barely enough HP for the job when pullied up for drilling. ***A 1-1/2 HP motor would be much better,*** especially when drilling holes for barrels larger than .25 caliber.

Suggested Improvement

BUSHING PLATE, CHIP BOX, SLED, AND GUIDE ROD ASSEMBLY

The fixed Bushing Plate assembly and the linear running Sled are fixed to and/or guided by a pair of 54" long x 1-1/4"ϕ rods (ground shafting material), spaced on 5-1/2" centers and anchored at their ends to the channel base, as shown in Detail #1.

The Bushing Plate/Chip Box Standard is 1" x 6-3/4" x 4" CRS and is positioned and locked as shown in Detail #5. A 1-3/4"ϕ bushing carrier, or Adaptor, is attached to the Bushing Plate by 2 socket head cap screws (shcs's) through slightly oversized holes. This allows the Drill Guide Bushing to be aligned with the Spindle via a centering rod and tapered spud, which is installed in the Spindle once, and indicated to run dead true (see info at Detail #6). Once properly centered via this centering rod/spud, the Adaptor Bushing is locked to the Plate, and remains undisturbed more or less forever after, and thus automatically centers any Drill Guide Bushing put into it. The Drill Guide Bushing which fits into the Adaptor Bushing is a hardened disc, 1-1/4"ϕ x 1/2" thick. A hole is drilled and bored a VERY close fit (almost a light press) to the diameter of the drill being used. This Drill Guide Bushing is used to start the gun drill dead center without a center hole.

The Chip Box traps oil and chips coming from the bore via the external "V" in the gun drill tube. The Chip Box is attached (oil tight) to the rear of the Bushing Plate. The Chip Box has a discharge pipe or chute at the bottom, which returns oil and chips via a 3/4"ϕ tube to a chip catching can/filtering unit. ***The size of the Chip Chute should be increased to about 2"ϕ.***

Suggested Improvement

Oil is returned to the tank via an overflow weir tube (a 4"ϕ PVC pipe sealed at the bottom with its base sitting on the floor of the oil reservoir tank). A discharge tube from the filtering unit carries the oil to the bottom of this larger pipe, where several magnets are positioned. These magnets collect any chips not picked off by the filter screens. The very fine chips formed by reaming are especially troublesome (altho they don't return to the oil reservoir by exactly the same route GBL).

The filter can (immediately downstream of the Chip Chute) should be large enough to hold all the chips produced during the drilling of a single barrel. On my existing machine this is not the case, which forces me to stop to empty the filter can during the drilling operation, which is a nuisance.

Suggested Improvement

In the video, you will note the use of a piece of sponge rubber, held in place by a piece of sheet steel, on the back end (or more accurately, the right hand end)

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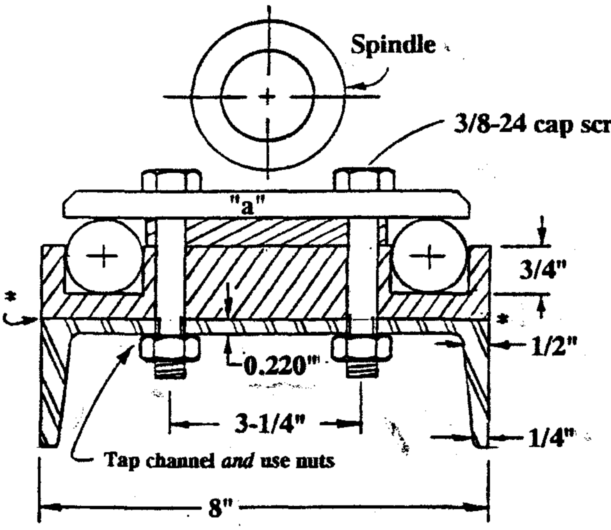
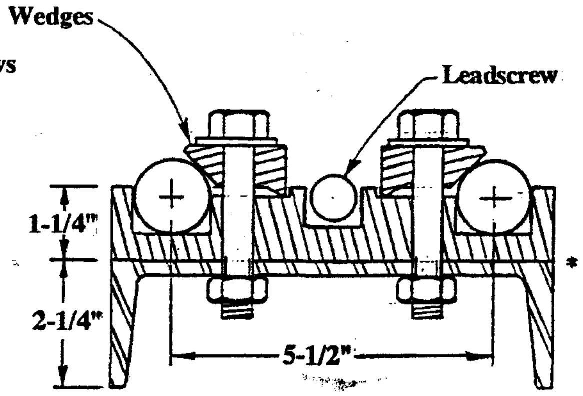
DETAIL #1 How the Bed Bars are locked down to the C-channel Main Frame



Looking toward spindle



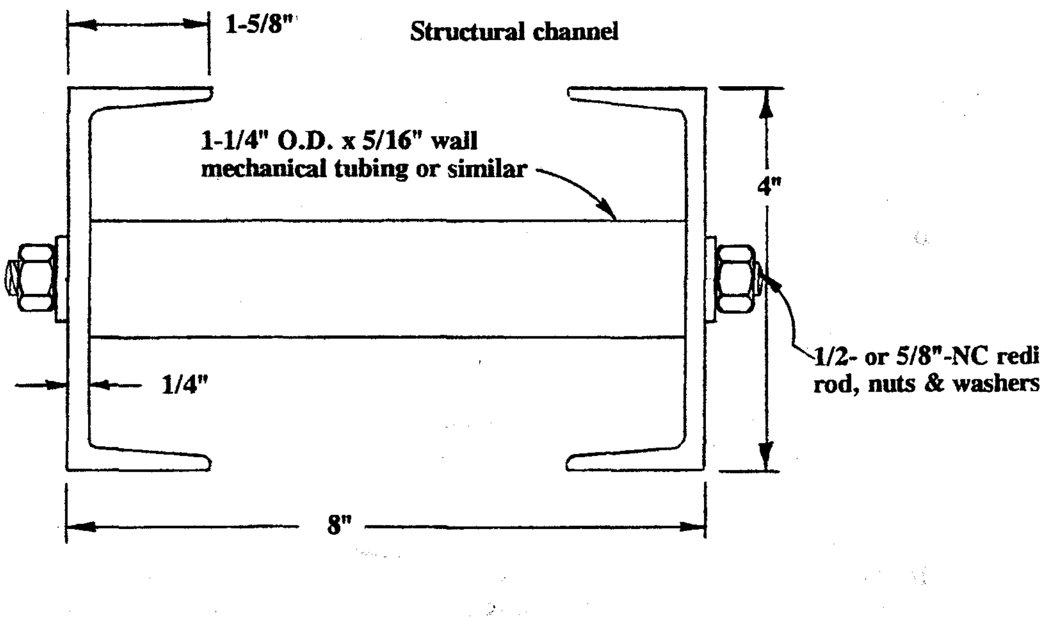
Looking toward gear motor

"C-8" = 8" x 2-1/4" x 0.220 C-channel

* Insert leveling shims as required at the 4 corners, to put Bed Bars in proper alignment full length.

The purpose of the support piece (shown in section - i.e. hatched) at left above under Clamping Strap "a" is to prevent bowing or bending the Clamping Strap when the cap screws are tightened down to clamp the Bed Bars into place. Short cylinders could be used instead of a piece of flat stock, and might be easier to make if you lack surface grinding facilities. Thickness should be just short enough to let the Clamp Strap have a good solid bite on the Bed Bars.

DETAIL #2 Here is a possible alternative to the use of "C8" in the construction of the basic frame of the Rifling Machine.



DETAIL #3 **Cat Head Details, and**

AN IMPORTANT SAFETY SUGGESTION

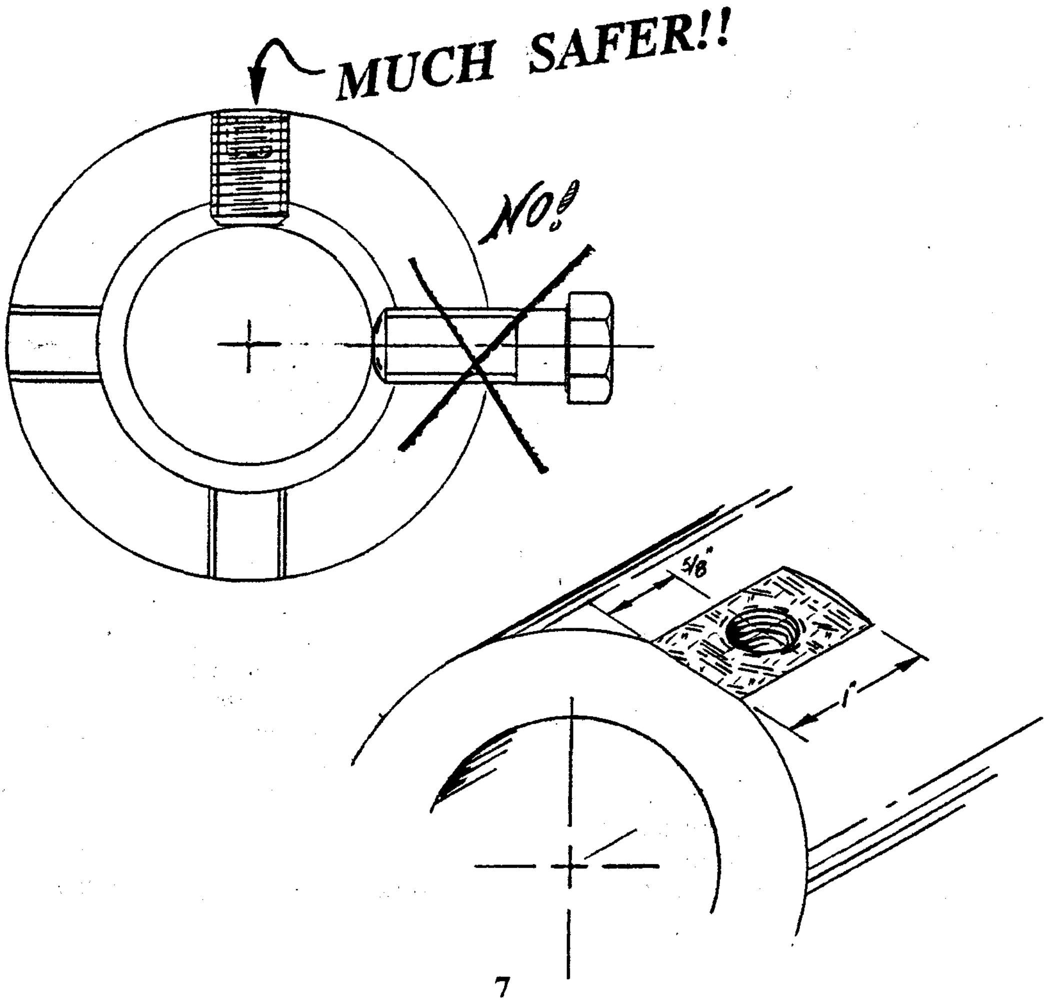
from

Guy Lautard

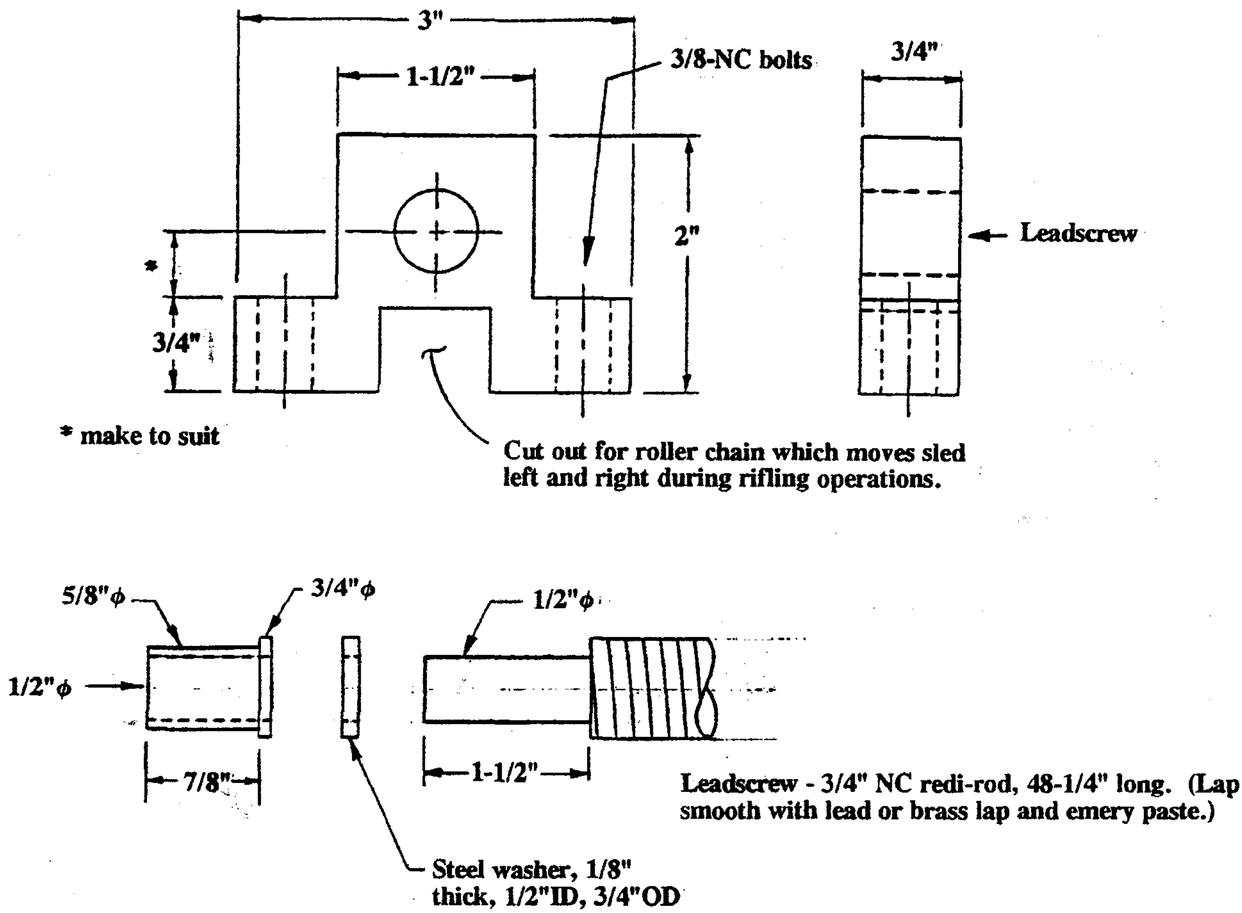
In the video, Bill mentions the desirability of having some kind of guard over the Cat Heads at each end of the Spindle, to protect one's fingers etc from the exposed portion of the bolts, which are almost invisible when the Spindle is running. Some while after the video was made, it occurred to me - and Bill agreed - that **it would be a very good idea to use 3/8-NF set screws instead of hex head cap screws.** I would buy them slightly over length, and then machine the working ends back until the socket end of each screw would sink just below the spindle OD when turned in enough to center up a barrel blank of the size I was going to use. I think I would at the same time counter drill the working end of each set screw and fit a replaceable brass or bronze tip. If a fella bought 16 set screws (so as to have a spare set), plus a couple of top quality allen keys, he'd probably be more or less set for many years to come.

This change from what is seen in the video would eliminate the hazard posed by those bolt heads stickin' out and buzzin' around at each end of the Spindle. What you'd have instead would be just a nice smooth cylinder, with nuthin' stickin' out to mow off fingers etc. If you wanted to, you could also put a couple of turns of electrician's tape or similar around the Spindle to cover the screw holes, once you had your barrel centered up and ready to roll.

I strongly urge you to make this change from what you see in the video.



DETAIL #4 Leadscrew Bearing Blocks



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of the Chip Box. The gun drill passes through this sponge rubber on its way into and through the Chip Box from the right. The sponge serves as a rough and ready sort of oil seal, to stop oil from leaking out the back end of the Chip Box. One person who viewed a preliminary version of the video suggested high-density rubber gasket material, or composition gasket material, or silicon caulking material, as alternatives (with the silicon idea being the least preferred of the 3, in his opinion). This is something to consider, at some point, in fine tuning your machine.

Another small point: Something else you did *not* see on the video was that when Bill was installing the gun drill, he also put a second piece of sponge rubber *inside* the Chip Box, and poked the point of the gun drill through same after it entered the back side of the Chip Box. This second piece of sponge, pressed back against the inside of the right hand wall of the Chip Box, serves as an additional improvised sort of oil seal, to make the leakage of oil from the back side of the Chip Box all that much more difficult. I don't recall how Bill kept this piece of sponge from moving to the left as the gun drill fed forward into the barrel blank. My own inclination would be to have steel sponge retaining plates

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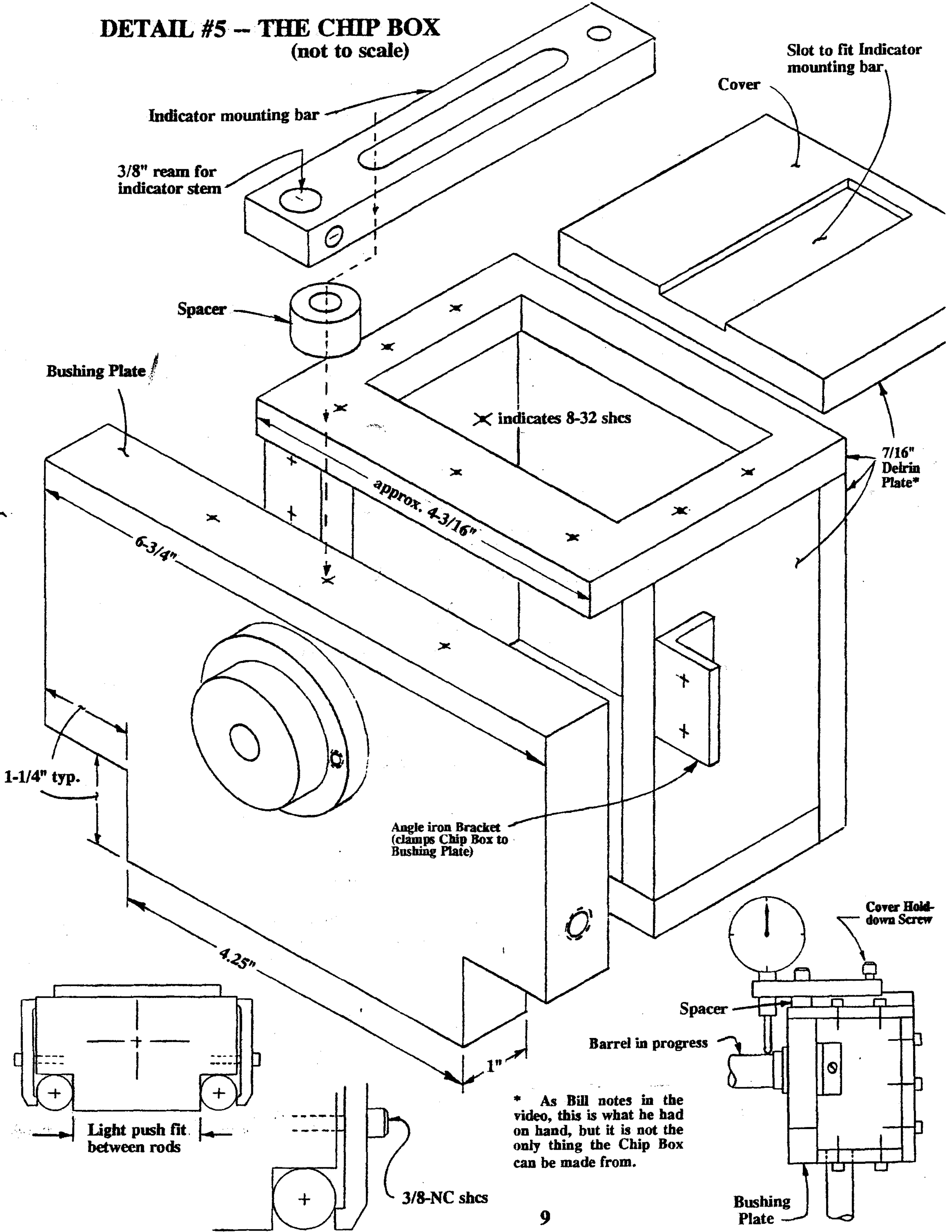
DETAIL #5 -- THE CHIP BOX
(not to scale)



* As Bill notes in the video, this is what he had on hand, but it is not the only thing the Chip Box can be made from.

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both inside and outside the Chip Box, on the rear (right) wall of the Chip Box, with a piece of sponge rubber trapped under each of them. This would have the same effect as what Bill did, and would be quite positive in its action. GBL

A sliding bar on the top of the Chip Box doubles as a latch for the Box lid, and as a bracket to hold the right hand barrel centering indicator. *(Naturally, the indicator is taken out of contact with the barrel blank before turning the machine on! Even the best of us can forget such things from time to time.)*

The sliding member located between the Chip Box and the main Sled is the drill tube support bushing plate, or "Whip Guide". An open top bushing is inserted to support the bottom (round) portion of the drill tube, while a Deleing plate with a male "V" bottom seats into the matching female "V" section of the drill tube, providing torsional stability to the tube during drilling. The plate that carries the Whip Guide serves other functions, such as a support platform for stoning the rifling cutter during the rifling process. It is also used as a cutter holder for making exterior-rifled air gage heads from bronze rod. (Unless you also own an air gage, this point is irrelevant to you. GBL)

The linear running Sled is 1/2" x 7" x 8" CRS plate. The tubes on the underside of the Sled are made from 2" D.O.M. 9/32"-wall tubing with 1-1/4" ID x 1-1/2" Oilite bronze bushings fitted in the ends. The open center section of each of these 2 tubes is filled with felt, and oil fittings installed.

Flats are milled on the top of the tubes, and the Sled plate is attached with screws and dowels to one tube. Similar screws, passing through clearance holes in the plate, secure the other tube to the underside of the plate. This makes it quite easy to get the 2 Sled tubes in perfect alignment with each other on the underside of the Sled.

The Universal Holding Block on top of the Sled is 2" x 2" x 2-1/2" CRS. It has a 3/4"ϕ hole reamed parallel with the machine axis. It is anchored to the Sled plate with 4 shcs's and 2 dowels. The knurled-head hand screw entering the Universal Holding Block from the top is for securing the drilling and reaming spindles in position in the Block.

Separate shank holding spindles to fit the Universal Holding Block are made for rifling and drill/reaming. The drill and ream spindle has a hollow 3/4"OD shaft which runs through the Block, and the rear end of this spindle is tapped 1/4" NPT for about a 3" pipe nipple which has at its other end a quick disconnect fitting for attachment of the oil delivery tube. This part of the spindle is drilled 1/4"ϕ through. The part extending to the front of the Block is 1-3/8"OD and has a 3/4"ϕ hole reamed approx. 2" deep to accept the drill and reamer shanks. A groove is cut toward the rear of this hole to accept an O-ring which seals radially against the drill or reamer tube shanks.

The Rifling Spindle is free to rotate in the Block, and is retained at the rear by a miter gear and bronze thrust washer. It is also reamed 3/4"ϕ in the front portion to accept the rifling pull rod. The gears and gear shafts are completely removed during drilling and reaming operations.

The gearing system required for rotating the rifling cutter starts with a 1/2" x 1/2" x 34" long piece of 16 D.P. gear rack. This Rack is attached to the edge of a 1/2" x 4" aluminum plate. The plate is attached to the back flange of the C-8 main frame channel with 4 bolts. The aluminum plate is slotted so vertical adjustment can be made to permit it to mesh with different size driving gears, which of course are required to produce different rates of rifling twist.

A 16 D.P. spur gear attached to the end of the cross spindle on the Sled meshes with the Rack, and as the Sled moves linearly, the spur gear imparts a rotary motion to the cross spindle. This rotary motion is transmitted to the rifle rod driving spindle by spiral miter gears (Boston Gear part #'s LSA102YR and LSA102YL).

The transverse spindle is 5/8"ϕ, and is carried in a pair of simple shop-made bushed pillow blocks. Side locking clamp collars retain the transverse spindle in position.

LINEAR MOVEMENT AND DRIVE SYSTEM

Linear movement of the Sled under power, for drilling and reaming operations, is from a 3/4"-10 leadscrew, which rides in bronze bushed steel blocks (See Detail #4) located at the ends of the leadscrew. The Leadscrew was bought as a 6' length of common, unplated threaded rod, often called "all-thread," or "redi-rod." A brass block was bored, threaded, and split to make a lap, and with it the Leadscrew was lapped in the lathe until smooth.

The drive for the Leadscrew consists of a reversible variable speed gearmotor attached to the rear of the channel (i.e. not exactly as shown in the General Arrangement Drawing GBL), and connected to the far right hand end of the Leadscrew through a couple of spur gears which also give a further reduction of the Leadscrew drive speed, which is approximately 0.000,2"/rev. for drilling, and 3 to 5 thou/rev. for reaming.

Since drilling and reaming are done in opposite directions, and at different speeds, it is a real convenience that the gearmotor is both variable in speed, and reversible, to obtain both proper speeds and direction.

A pair of bronze half-nuts are attached to a block on the rear underside of the Sled plate to engage the 3/4"ϕ Leadscrew. When leadscrew drive of the Sled is wanted - as it is for the drilling and reaming operations - the 2 half-nut pieces are tapped in against the Leadscrew and then clamped and locked in this position with two hex-head bolts.

For rifling, the half nuts are disengaged, and the Sled is powered by hand. A sprocket is attached to the center of the axle that is turned by the handwheel seen in the video. A second sprocket is attached to the center of an axle located near the far right hand end of the C-8 main frame channel. Number 40 roller chain is run around these sprockets and attached to the Sled bottom via an adjustable take-up screw, which removes chain slack.

OIL PUMP AND LUBRICATION SYSTEM

Cutzol SCFO 504 cutting oil is used. The oil reservoir holds about 10 gallons. In addition to the overflow filtering system, the bottom of the tank is lined with magnets. The outflow to the tank valve should be filtered, although it is not on my machine. Oil is piped from the tank through 1/2"ϕ copper tubing to the pump.

A pre-pumping filter of 10 microns or so would eliminate most problems with erratic oil pressure, which otherwise requires constant adjustment of the valve. At 3/4 HP, my oil pump motor is too small to use the sort of filtering system one ought to have. **Suggested Improvement**

1/4" black iron pipe leads from the pump to a T-fitting. One side of the Tee is connected to a high pressure flexible hose which terminates with a ball check connector fitting for attaching to the drill and ream tube shanks. The other side of the Tee runs through a pressure gage and high pressure hand valve, returning excess oil flow to the tank through a 3/8" copper tube. This hand valve controls the pressure, which I

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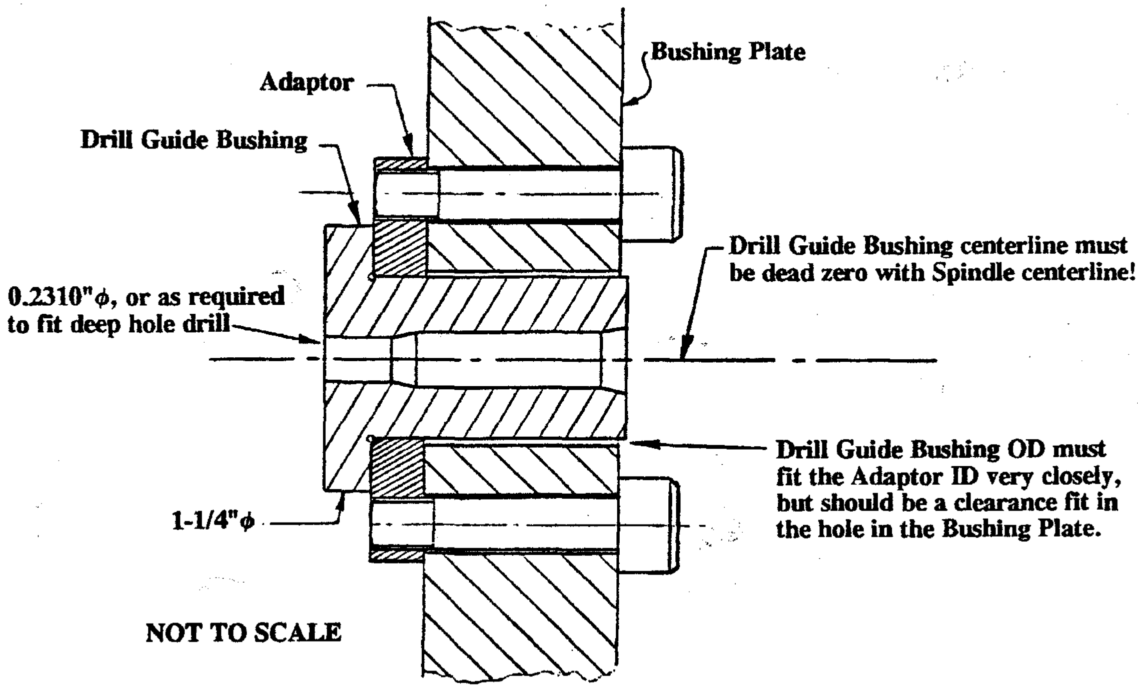
DETAIL #6 -- Alignment of the Drill Guide Bushing



Float Drill Guide Bushing and Adaptor into perfect alignment with Spindle centerline, by means of an alignment spud mounted - and *VERY* carefully centered up! - in the Rifling Machine Spindle, and then tighten the Adaptor Bushing mounting screws from the other side of the Bushing Plate. If you later wish to make a barrel with a different bore size, you need only to remove the Drill Guide Bushing, and substitute another one of the appropriate size. If its ID/OD concentricity is perfect, you will not need to realign the Adaptor and the Rifling Machine Spindle - they remain in proper alignment more or less permanently.

a further note about.....

MACHINE ALIGNMENT

The axes of the Spindle and Bed Bars need to be in reasonable, but not perfect, alignment. What is critical is that the Drill Guide Bushing and Spindle centerline be lined up absolutely dead nuts. For the rest, the better the better, but perfection is not required. The structural steel main frame piece should be straight enough to provide much of the needed alignment, without resorting to autocollimators and similar to get the Spindle and Bed Bars lined up with each other. From there, careful shimming, guided by the use of a precision level - e.g. a Starrett No. 98 or similar - should do the job.

Instead of a level, you could set up a peep hole and crosshair arrangement in the Spindle and take sights on a target on the Sled, which you would then move along the Bed. If you want to go completely overboard, you can align the Spindle and Bed Bars with a transit, but it is not necessary. If you've ever had an interest in optical matters, you will probably know other tricks that could be applied, like putting a light bulb in behind dual peep holes in the Spindle, thus projecting a coherent beam of light onto a Sled-mounted target.... but I'd be getting well out of my depth if I said much more along that line. GBL

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normally run at about 700 psi for drilling, and drop to about 150/200 psi for reaming.

NOTE

The quick disconnect arrangement shown on Bill's machine is probably the best way to pipe the oil system, for safety, as is the use of a by-pass arrangement to control oil pressure and send excess oil back to the oil reservoir. This setup also ensures against running the oil pump short of oil due to a clog-up (although you'd soon enough know about it if you had a clog-up!!).

A recommended modification to the oil supply piping is shown on the General Arrangement Drawing at page 3. This modification would be the addition of a **pressure relief valve**, set at say 1000 psi, in the short horizontal pipe running from the pressure gage to the high pressure hand valve. From this **pressure relief valve** you would run a by-pass line (shown as a pair of dotted lines connecting back in to the main by-pass line just downstream of the high pressure hand valve. GBL

Suggested Improvement

The pump is powered by a 3/4 HP 3450 RPM motor. (This is too fast and too weak, hence we arranged a 5:1 speed reduction via belt and pulleys.)

SUITABLE STEELS TO USE FOR MAKING RIFLE BARRELS

Before we get into a discussion of operating procedures, we need to discuss suitable steels to use for making rifle barrels.

WARNING re "merchant quality" steel.....

Barrel Steel:

Most steels suitable for use as rifle barrel material are available from your local steel distributor's warehouse. Typically, what you will want to buy is 1-1/4"ϕ round bar stock, which comes in 12 to 20' lengths. You may wish to have the supplier cut your material into some convenient multiple of your intended barrel blank length (28 to 34", or whatever suits your requirements) plus a little extra for sawing allowances, so you can get it into your vehicle for the trip home.

The first, and most important consideration in barrel steel selection is safety. To be considered safe for use in rifle barrels, the steel MUST have the mechanical credentials to withstand the pressures encountered in high-power rifle shooting. Stated briefly, this is as follows:

- Hardness - 28 to 32 on the Rockwell "C" scale.
- A ***minimum*** tensile strength of 130,000 psi at the above hardness. ***Anything less is considered unsafe or even dangerous!***

Another consideration: most of the steel carried by steel warehouses is termed merchant quality (if carbon steel), or commercial quality (if alloy steel), rather than gun barrel, or rifle barrel quality. This means it *could* be subject to flaws such as laps, seams, or

inclusions. Although the risk of a barrel failure due to the use of this quality of steel is low, the risk is still there. My recommendation would be to stick to steels that are considered entirely suitable - in other words,

- Hardness - 28 to 32 on the Rockwell "C" scale.
- A ***minimum*** tensile strength of 130,000 psi at the above hardness. ***Anything less is considered unsafe or even dangerous!***

as already stated above.

It does not take a genius to realize that if you make a barrel that falls into someone else's hands - even by theft - and they are injured by it "coming apart", you're likely to have some serious legal problems on your hands.

Some of the more common steels suitable for shop made rifle barrels are:

AISI 4140 through 4150 High Tensile Chrome Moly steel
AISI 41L40 and 41L42 High Tensile Chrome Moly steel
Type 416 Stainless Steel Martensitic Stainless Steel

AISI 1140 Stressproof has been used for making "learner" barrels, as it cuts well, but it's not considered to be safe for use in "using" barrels. Even though it may appear *on paper* to have suitable mechanical specs, the cold drawing process employed in its manufacture **renders it too risky for rifle barrel use** due to possible laps, stringers, and/or other inclusions. It would probably be best to exclude it entirely. If you do use it for making a few early practice barrels for learning purposes, **YOU SHOULD DESTROY THEM THE DAY YOU MAKE THEM**, to avoid any possibility of their being used at a latter date by yourself, by accident (after you've forgotten what steel you used), or by someone else through ignorance of the steel used - after all, if it looks like a rifle barrel, then it must be a safe rifle barrel --- right? NOT ON YOUR LIFE!!

It would be wise to set up a safety test procedure (i.e. proof firing) to insure the safety integrity of any barrel you make, especially if it could be passed along by sale, gift - or even theft - to another user.

OPERATION

Please re-read the above info on suitable steels to use for making rifle barrels.

DRILLING

Barrel blanks are cut to 28" long from 1-1/4"ϕ x 12' bars of 41L40 (Rycut 40). I also use 416R stainless, a special formula rifle barrel steel, when available.

A steady rest with ball bearing tipped steady fingers is set up on a lathe with the aid of a dummy set-up bar. A blank is then chucked by one end, with the other of the blank riding in the steady rest. The blank is faced square and a light cut taken on the outside - 5 thou deep x 1/2" down the blank is about right. Reverse and repeat at the other end of the bar. (Actually, facing both ends of the bar is not absolutely essential.) No center hole is drilled in either end of the blank. You want a very nice finish on the OD turned

area, but you do *not* want a fine finish on the end of the blank - here a less-than-smooth finish helps retain oil - see next paragraph.

The blank is removed from the lathe and set in place in the rifling machine Spindle, with the turned and faced end of the blank against the Drill Guide Bushing. The blank-to-Bushing joint should be lightly greased or oiled to prevent galling. With dial indicators in place at both ends, the blank is adjusted by adjusting opposing bolts in the Spindle cat-heads until both ends of the barrel show zero runout. The front or right hand indicator reading is most important. This is why we take that light cut on the OD of the blank - to make sure it is round and smooth for the indicator.

The Spindle is then started and allowed to run for about 10 minutes to warm up the grease in the bearings.

The machine is rigged for the drilling mode, and the gun drill is attached, via the shank holding spindle, to the Universal Holding Block on the Sled. The point of the gun drill is threaded through the Whip Guide, and then through the Chip Box and into the Bushing in the Bushing Plate, to which the Chip Box is attached. The Spindle is started. With zero oil pressure, the drill is started into the barrel using the handwheel, pecking in 1/16" or so and backing out to remove chips. This is continued until the hole is about 3/4" deep.

With the Spindle motor off, the drill is then run in to the bottom of the hole, and then backed off about 1/16". The leadscrew half nuts are tapped into position and locked onto the Leadscrew.

The oil pump is started, and adjusted to 300 psi. The Spindle is started, and then drill feed is initiated, with the feed rate set at about 0.5 to 0.7"/minute, which translates into about 0.000,2 to 0.000,25"/rev. After ascertaining that all is running smoothly, oil pressure can be slowly raised to about 650/700 psi. as the drill progresses further into the barrel blank.

> **Note:** Deep hole drills are manufactured by Danjon Mfg. Inc., 1075 S. Main St., P.O. Box 212, Cheshire, CT 06410-0212.
>
> NOTE: Danjon will sharpen gun drills returned to them for this service, but you can also sharpen your own drills - see separate sheet titled **IN-HOUSE GUN DRILL SHARPENING** (page 33) for some useful info on this topic. GBL

Usually 2 or 3 stops are required in the course of drilling a barrel blank, to clear the Chip Box and empty the filter can. The latter is simply a modified coffee can with 2 or 3 layers of door screen set in the bottom. This prevents most of the cuttings - and there are a lot of them! - from entering the oil reservoir.

The drilling is stopped about 1/2" before it exits the blank. Drilling time is about one hour. You don't want to let the drill break through the far end of the blank. If it does, oil spewing out under several hundred psi will create an unbelievable mess in less time than you would ever imagine.

Once the hole is in to full depth, the barrel blank is removed from the cat-heads, the end is cut off, and the cut end is faced off clean in the lathe. This is where you get the good or bad news on hole run-out.

I have found that reduced drill feed rates tend to produce a straighter hole - I did one that showed 0.000,6" TIR - which must be a record for straight, and no doubt for pure dumb luck as well. Perfect hole straightness is not required, and never obtained. I can usually drill to less than 0.010" TIR, and often get results much better than that. Obviously, the straighter the hole comes out, the better you are going to feel about it.

REAMING

After removing the drill, the drilled barrel blank is returned to the rifling machine Spindle (with the "chamber" end at the far left hand end of the Spindle), and indicated true again. The Bushing Plate/Chip Box assembly is removed, and the Sled is brought up close to the end of the barrel blank.

The leadscrew drive motor is changed to the "ream" mode, i.e. to the opposite feed direction, and its speed is increased to give a feed rate of about 3"/min., or 4-1/2 thou per rev. The main drive motor V-belt is shifted to the larger Spindle pulley, to give the reduced spindle speed (approx. 650 rpm) required for reaming.

The reamer pull tube* is run through the barrel blank from the left hand end of the blank, and attached to its drive shank and holder. The Sled is positioned so that when the reamer pull tube drive shank is connected to the Universal Holding Block on the Sled, the reamer (at the opposite end of the pull tube) is nearly touching the left hand end of the barrel blank. At the left hand end of the Spindle, a PVC pipe elbow is swung into position to catch the stream of oil and reamer cuttings coming out the left hand end of the barrel blank. This elbow deflects the oil and cuttings downward into a magnetically filtered loaf pan which traps the cuttings, while the oil returns to the oil reservoir via a vinyl tube.

> * Reaming the drilled barrel blank requires the making of a suitably sized steel tube to attach to the reamer. This tube pulls the reamer through the bore, and feeds oil to and past it at the same time, to wash away the fine cuttings produced by the reamer.
>
> Pull tubes are made from 4130 aircraft tubing, turned down to suit the size of the hole to be reamed. The tubing is available in fractional diameters, starting at 3/16", and increasing by 1/16" increments. Various wall thicknesses are available - in the case of 1/4" OD tubing, you can get 0.028", 0.035", 0.049", and 0.058" wall. Bill says that for 6mm barrels, he starts with 1/4"OD x 0.058" wall thickness. Bill gets his tubing from the undernoted outfit, which sells supplies for home built aircraft.
>
> * Air Parts Inc.
> 2400 Merriam Lane
> Kansas City, KS 64106
>
> Your first reaction is likely to be that turning down a 30" length of 1/4" OD tubing would be difficult, if not impossible. However, at page 32 of this document you will find dimentioned drwgs of a simple, combined turning tool and travelling steady bushing you can make, that will make the job fairly easy.

Spindle, feed, and oil are started, and the first reaming pass begins. After the first reaming pass, the second, or finish, reamer, on its own pull tube, is installed and the process repeated. Oil pressure is held at about 150 psi. Reaming time is about 15 minutes per pass.

The reamed hole is air gaged, and lapped* in the lathe for uniform dimension - 0.000,1" max. variation from end to end - before rifling. This also removes most of the reamer marks, so that the bore looks like a mirror.

> * Bill was reluctant to say very much about lapping barrels. In fact, getting anything about lapping out of him was about like pulling teeth. When I put his feet to the fire a little, he finally said he would tell me a bunch of stuff, once he knew something about the topic. Well, that wasn't good enough, so I persisted, and finally uncorked a small fountain... See the section on lapping, at page 21-24 of this document. *Added later: Bill is now trying aluminum oxide, instead of silicon carbide, but says he hasn't yet developed a preference for one or the other.* GBL

RIFLING
The machine is cleaned up, and reconfigured for rifling - gearing installed, etc. The barrel blank is left in place in the Spindle* after final reaming, to save the time required for re-indicating, etc. The Stoning Support Bushing is pressed into the Whip Guide bushing hole, and the Index Plunger is set to mesh with the appropriate row of holes in the Index Sleeve for the number of rifling grooves you want.

> * (It is not <u>necessary</u> that the barrel blank remain undisturbed in the Spindle between reaming and rifling. Obviously, if you were making 3 barrels of a given size at one time, you would ream all 3, and leave the last barrel blank in place after reaming; once that barrel was rifled, one of the other two would be re-installed, re-indicated, and rifled. GBL)

The Rifling Head/pull rod assembly is then slid into the barrel from left to right and attached to the shank holder, and the shank holder is then fitted into the Universal Holding Block on the Sled of the rifling machine. With the rifling cutter fully lowered in the Rifling Head, the Sled is cranked to the right, pulling the Rifling Head through the bore, and beyond, until the rifling cutter arrives in the Stoning Support Bushing.

The Rifling Head is then rotated so that it will be in a convenient "face up" orientation for stoning of the rifling cutter while in the Stoning Support Bushing; this is done by disengaging the spur gear from the Rack and rotating the Rifling Head. The gear is then re-engaged and the Sled cranked to the left, returning the Rifling Head to the far (left) end of the barrel.

> Here's another small point that Bill did not comment upon in the video: In converting the machine from drill/ream to rifling mode, when he raised the Rack up into engagement with the spur gear, he meshed them so snugly together that there was virtually no play between the spur gear and the Rack. Obviously this is not normal machine shop practice, but it is desirable in this particular application - the prime objective is to make the best possible barrel, not to obtain maximum gear life. GBL

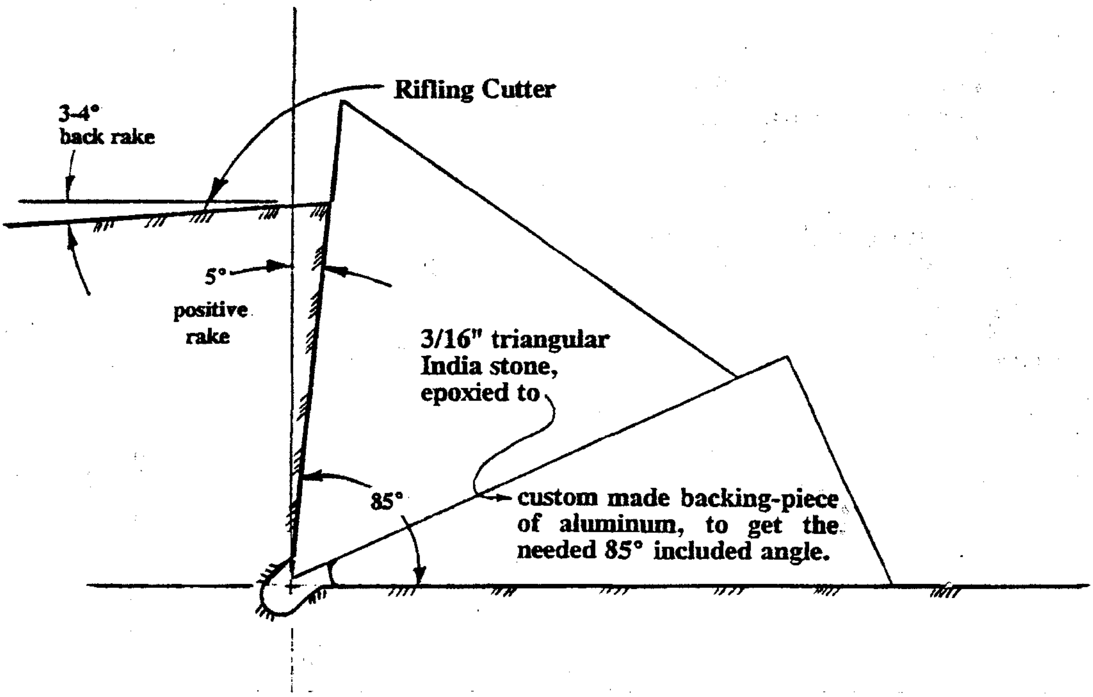
> *And here's an off-shoot to the above, which Bill told me later:* If you want a slight gain twist (i.e. rate of twist increasing towards the muzzle), you can drop the left hand end of the Rack down about 10 thou from real tight contact with the spur gear, and have it right up to the zero play setting at the right hand end. This will produce a very slight gain twist. GBL

The rifling cutter is raised until it barely touches the bore, and a trial pass is made. The initial cuts must be *very* light, in order not to torque the rod and influence twist

uniformity. One pass is made at each index setting (i.e. for each rifling groove), before raising the cutter up another 0.000,1" for another round of passes. After 4 or 5 of these light passes in each groove, it is a good idea to make a pass in each groove without increasing the cutter depth at all. This is where a delicate, experienced touch is needed, and soon gained.

IT IS IMPERATIVE THAT THE CUTTER BE KEPT RAZOR SHARP. This is, I believe, one of the most important parts of making a good barrel. The Rifling Head is run up into the support bushing after every 3 or 4 rotations of the Spindle in the indexing ring, and the face of the rifling cutter stoned with a fine India stone or a fine diamond steel hand lap. The drwg below will give you some ideas re stoning the rifling cutter. (Text continues on next page.)

STONING THE RIFLING CUTTER



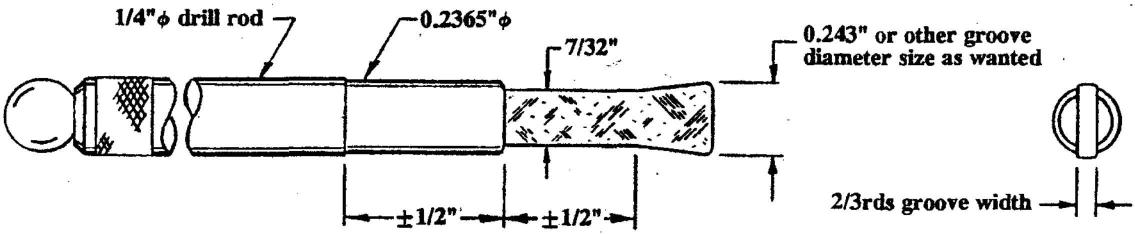
Bill says he feels a fine India or hard Arkansas slip does a better job of stoning the Rifling Cutter than a diamond hand lap such as he is seen using in the video. If you make up something like what you see here, you'll be well fixed to do the job right... Or, to coin a phrase, "Pope's yer uncle!"

While I was putting the last licks on this document, Bill and I talked again on the phone, and he pointed out something that had not occurred to either of us before: Another possible way to handle this whole matter would be to tip the rifling cutter up 5° before grinding the step that creates the "rifling cutter" part of the rifling cutter. This would cause the horizontal line in the above drwg to be angled down 5° from left to right, and would give a 90° angle between the face of the rifling cutter and the adjacent surface. Made thus, the rifling cutter would certainly look a little less handsome, but it would make it very simple to stone the face of the cutter with a square India Stone! (How enormously convenient!) This would necessitate a similar change in the Stoning Support Bushing, re which see preceding page. GBL

When you are cutting the last half thou or so of rifling groove depth, super fine cuts are made, during which the cutter will bring out nothing but ultra fine fuzz, and very little of that.

Groove diameter is frequently checked with a go-gage until finished size is reached. The entry and exit portions of the bore are usually constricted somewhat, which means that your gages should be made long enough to reach in a little way past the first inch or so of the bore.

A SIMPLE SHOP-MADE BORE AND GROOVE MEASURING TOOL



Dimensions given are for a 6mm barrel

The barrel is then removed from the machine, cleaned, and checked with the air gage** for groove uniformity. If the reamed hole was uniform before rifling, then the grooves will almost certainly be also.

The bore is wiped out using very fine steel wool wrapped on a jag. Six or 8 round trips with this is all that is needed. The rifled bore should then look butter-smooth, with a polished sheen if the barrel is chrome-moly steel, or like a mirror if stainless!

> ** The purchase of an air gage will almost completely deflate your wallet. Bill happens to have one. If you don't, don't worry - you can learn quite enough from lead slugs pushed through a barrel. (Actually, pushing a slug *right through* will only tell you the minimum diameter, and whether or not there are tight spots.) Harry Pope did it that way - and taught one of the superintendents at Springfield Armory the same trick! - as you can read in *H.M. Pope - Last of the Great Gunsmiths,* in my book, **The J.M. Pyne stories and other selected writings by Lucian Cary** (US$26.95.) GBL

The actual job of cutting the rifling takes 4 to 5 hours if you are super critical, and start and finish carefully. The neophyte will want to stop and look through the bore every few passes. This eats up a lot of time, but the need to do so passes after the first few barrels. A perfectly fine rifling job can be done in about 3 hours, after some experience is gained. However, a fine barrel is the objective, not a fast job. You can ruin a lot of careful work that has gone before if you get in a rush at this stage. Be patient.

> *At a couple of points in the video Bill speaks of "the rifling box," and I think in at least one spot he refers to it as "the cutter box." More often he uses the term*

"the rifling head." All refer to the same item - the little milled, drilled and tapped slug of drill rod that carries the rifling cutter. GBL

IDIOSYNCRASIES OF CUT RIFLING

Groove diameter will be inversely proportional to the bore diameter. Since the rifling head is always supported by the wall opposite the cutter, the depth of cut will be governed by the diameter of the hole. If, for instance, there is a pronounced loose spot in the bore longer than the cutter body can bridge, the resulting groove diameters will be tight.

This little quirk can be put to good use. For example, suppose we wanted a choked bore. Simple. Make the loose end of the reamed bore the muzzle. Subsequent rifling will most likely yield a tight groove diameter at the muzzle. After rifling, the lands are lapped level, or choked toward the muzzle as desired.

(This idea struck me as a little odd, coming from a guy who - as you will very soon see - is not entirely and overly fond of the whole idea of bore lapping, so I phoned Bill, to question him on it. His response was that while he had said above that this idea was possible, he didn't necessarily think it was a GOOD idea. He also let slip a few more ideas he hadn't mentioned to me before, like using cast iron laps sized to lap only the lands, and not the grooves, copper laps, and so on. We agreed to tapper off from the above by saying that although this might be a great way to gain some useful experience on the whole subject of barrel lapping, this type of experimental activity should probably be reserved for barrels you are not already entirely pleased with, because there is always the possibility you will not like your results. GBL)

I prefer to rifle my barrels from the breech to the muzzle, altho it probably should be done in the other direction. As with any standard metal cutting tool, such as used on a shaper or lathe, a chip is created that must break away from the parent material sooner or later. At each such point, an abrupt abutment will be generated in the grooves. Although minute, these will present a "knap" or roughness to anything travelling in the same direction in which the cutting was done. If you rifle from breech to muzzle, the barrel will show heavy fouling until it's had a number of rounds through it. The knap can also be removed, or at least much reduced, by lapping, re which see attached supplement on lapping. Otherwise, cut your grooves from muzzle to breech, and the bullets will think the ride out is smoother.

MISCELLANEOUS TOOLING NOTES

We fluted, heat treated and ground our own bore reamers, but I would not do it again. David Kiff, of Pacific Precision Grinding (P.O. Box 2549, White City, OR 97053) makes very fine quality carbide reamers for reasonable cost. These outperform shop-made reamers, will last a very long time, and can be resharpened.

(There is some excellent material - part of it from Bill Webb himself - on hand stoning of reamers in my book **The Machinist's Third Bedside Reader**, and you might find it useful to study that material if you want to sharpen your own bore reamers. However, if you buy carbide bore reamers, they will in the first place do many barrels before they require sharpening, and the equipment

required to sharpen them is such that you would almost certainly find it far better to return them to the maker for sharpening. GBL)

Commercial bore reamers are 4- or 6-flute*, with minimum clearance, and have about a 1-1/2° cutting cone angle. We made ours with pilots, but I don't think this is really necessary if you use as small a cone angle as we did. We also made then to screw on to the pull tube, but the commercial ones are silver soldered on.

* *4 flute reamers for roughing, and 6 flutes for finishing.*

Most bore reamers are silver soldered directly into the tubes. As noted above, the tubes are 4130 and are available in different wall thicknesses from Air Parts Inc. After the tube is turned to a size to fit the bore, the reamer is soldered into the tube. This is best done in the lathe with the tube indicated in the 4-jaw, and the reamer held in with the tailstock center. They must be perfectly aligned.

IMPORTANT NOTE

In setting up to solder a reamer to its pull tube, **it is imperative that the axial alignment of the reamer and the pull tube be true.** This can be achieved by chucking the pull tube in your lathe and indicating it, and then setting the reamer in place and keeping it there with the tailstock center. Then run the lathe slowly to see if everything is in proper alignment, before soldering.

BARREL LAPPING

According to the gunsmithing texts, lapping rifle barrels is an art, rather than a science. I have not had nearly enough experience lapping finished barrels to consider myself qualified to comment expertly on the subject. This may be a good thing: being somewhat skeptical of published rifle barrel information, I approach the lapping process from a different procedural and philosophical point of view.

First, I'm not entirely sure I would call barrel lapping an "art", nor do I like to do very much of it. After going through all the precise machining and measuring procedures required to make a rifle barrel with tolerances in tenths of a thou, why would anyone "carefully hand lap" this piece of precision machine work?

"Careful hand lapping" - often alluded to in barrel ads and general gunsmithing books - refers to pushing and pulling through the bore, by hand, an abrasive-charged lead lap. The lap is formed by pouring molten lead into the barrel, usually after inserting a steel rod on which masking tape or similar has been wrapped to form a plug in the bore. Formed in this manner, the lap becomes (temporarily) attached to the end of the steel rod. A ball bearing handle arrangement is relied upon to allow the lap to follow the twist of the rifling. To commence the actual lapping operation, the lap is partially withdrawn from the bore, charged with abrasive powder of some sort, pushed back into the bore, and then used as described above.

This time-honored procedure may be ok for some folks, but I just can't buy it. First, it's hard to believe that pouring molten lead into the end of a rifle barrel won't draw the heat-treat to some degree, and therefore have a destabilizing effect, even if it is only at the muzzle.

The lap is, at best, likely to be encumbered with voids and seams as it is cast in the barrel. To try to use such an imperfect item to lap a barrel would seem to me more than likely to cause an uneven lap area, which in turn, would not do bore concentricity any good. The objective is to correct very small dimensional errors, and to improve the bore's concentricity. We don't want to introduce large errors, and we're not doing it to make the bore shine - it's not a polishing operation, although Harry Pope called it that. The fact that lapping does make the bore shine is just a minor bonus.

Another potential complication of "freehand lapping" is the risk of damaging the lands with a bent lapping rod or from bowing the rod on the push cycle. These rods, especially in smaller calibers, are necessarily rather flimsy, hence difficult to push without bending. When such a rod becomes charged with lapping compound, as it invariably will, the poor vulnerable lands become the indiscriminate victim. Lands lowered eccentrically by lapping can cause endless mischief. A lack of concentricity between bore and groove diameters means trouble when throating, since piloting is normally done relative to the bore. It's also bad news for bullet balance, since the bullet's axis of form and center of gravity axis will no longer be coincident.

Considering the performance of today's match grade barrels, many of which are lapped in just such a manner, the above concerns may be just so much "Chicken Little" anxiety. But there are barrel-to-barrel differences, even in the highest quality barrels ... who knows what part lapping played in causing these differences?

My approach to lapping relies a little more on control and a little less on the art form. First, I don't cast a lap on the end of a rod in the rifle barrel. Mine are made from 9/32"ϕ extruded lead wire, which I cut to a length of about 1-1/2" and then prepare as follows:

The 1-1/4" long slug is rolled between two heavy metal plates, which makes it pretty much straight. The slug is then put into an appropriate collet in the lathe, faced, and center drilled at both ends. One end is then drilled and tapped 6-32 (for 6MM and .25 cal. barrels) about 3/4" deep, to take a threaded stud affixed to the end of the lapping rod.

A dummy stud is inserted in the threaded end of the lead slug, and held in a 3-jaw chuck. With a ball bearing center in the tailstock, the slug is turned to a diameter approximately 2 thou under groove diameter. Circumferential grooves are turned about every 3/16" or so along the length of the slug to carry the lapping medium, and also to make obduration of the slug into the barrel easier.

The lapping rod is made from drill rod, and is kept as short and stiff as possible. One end is threaded with the appropriate thread (or drilled, tapped, and a threaded stud inserted) about 3/4" long. An adapter is made to fit the Rifling Spindle* nose socket (which runs in the Universal Holding Block, and rotates, via the rack and pinion gearing, to produce the rifling twist). This adapter is attached to the non-business end of the lapping rod.

** this part of the Rifling Machine*
is first referred to at Page 10.

A steel bushing is made with an ID about 2 to 3 thou over lapping rod ϕ, and with an OD to fit into the Whip Guide bushing hole.

The barrel to be lapped is centered in the rifling machine Spindle, with its muzzle end at the left hand end of the Spindle.

The lapping rod is then fed through the lapping rod bushing in the whip Guide, and attached to the Rifling Spindle nose (which has been detached from its driving gears) in the Universal Holding Block, and locked securely. The Whip Guide is positioned so that the lapping rod bushing is about 2-1/2" from the end of the barrel. The lap is anointed with cutting oil (but not with abrasive) and screwed onto the rod-nose stud.

It should be noted that about 3/4" of both ends of the barrel will have been removed before lapping occurs. This represents the constricted portions where the Rifling Head entered and exited the bore. *(If the constricted portions of the barrel were not cut off, they would swage down the lap, and it would have little effect in the rest of the bore.)*

The initial entry of the lap into the bore may be a bit difficult. If the lap doesn't enter with a bit of bumping with the handwheel, a more drastic approach may be necessary. Disconnect the rod from the Rifling Spindle nose and back the Sled a few inches to the right, to get it out of the way.

Now, using a soft face hammer, gently tap the end of the rod, forcing the lap into the barrel. Once the lap has entered the barrel its full length, mark the lapping rod with a magic marker or layout dye, so you will know when the lap is about to exit the barrel.

Slide the uncharged lap through the oiled barrel a couple of times. Mark the rod so you will know when the lap is about to exit the other end of the barrel, as well.

If by accident you do exit either end with the lap (and you will!), be sure to "feel" the lap back into proper register. Once you have the rod running smoothly, you are ready bump the lap up to groove diameter. A "bump-up" rod is made from drill rod, near bore diameter, and about an inch longer than the barrel. The ends should be faced off square but without sharp edges or burrs.

Start the bump-up procedure by locating the lap about an inch or two in from the breech end. Insert the bump rod into the muzzle and slide it down the bore until it contacts the lap. Holding the lap stationary with the handwheel, lightly tap the bump rod a few times with the mallet. Slide the lap forward a couple of inches and bump again. The lap should be bumped a little at a time, so it will not become too tight and seize in the bore.

The lap should always be moved forward rather than rearward after bumping to reduce the chance of stripping the threads in the lap. Once it has been determined that the lap is fully obdurated into the grooves, and is running freely in the barrel, slide the lap nearly out of the breech and apply a small amount of lapping compound (such as 280 grit silicon carbide).

Slide the charged lap the full length of the barrel a couple of times. You will notice there is a lot more drag now. Locate the tight spot (if any), and try to locate the lap in its center. Mark the rod at this spot, and lightly bump up the lap. Lap back and forth only in this tight area, bumping the lap as necessary. Occasionally move the lap to both sides of the tight spot to see how the tight spot feels compared to its surroundings. Once the constriction has been removed, blend the lapped area in with longer strokes. Continue to feel for, and remove, tight spots until the barrel appears smooth for its entire length.

If you have an air gauge or other device capable of measuring groove diameter, now is the time to use it. Keep the lap engaged, and in register, at the extreme breech end while measuring from the muzzle. For more shine, or polish, a lap charged with 320 grit silicon carbide can be used as a follow-up. Such abrasives can be bought at a lapidary shop, or tool supply house.

Some further random thoughts on the lapping process:

If I were planing to make and lap many rifle barrels of match quality, I would consider having a dedicated lapping bench. Such a bench would consist of a barrel cradle to clamp the barrel stationary without having to "dial it in"; the lapping rod spindle would rotate on ball bearings and be guided with shafting or ways of some sort. At least one guide bearing would be utilized to hold the lap rod in line with the bore. It could be push-pull manpower operated and equipped with slide stops to position the lap with respect to the barrel axis. The whole proposition would have to be anchored solidly, as there is considerable force involved.

Fire lapping: *Precision Shooting Magazine* once published a series of articles by Merril Martin about a lapping procedure called fire lapping, in which several lead bullets charged with an abrasive compound were fired down the barrel of a rifle with a relatively light charge. According to the author, this method produced a bore much improved in both appearance and uniformity. It reportedly removed tight spots, smoothed the bore, and imparted a slight amount of choke. All of this in rather rough and non-uniform factory bores. If this works for bores of this class, think what it might do for new, smoothly rifled bores, needing only some TLC to become super match-grade barrels!

In the spirit of progress (and curiosity) I have made a fire-lapping breech to connect to the breech end of 1-1/4" barrel blanks. It locks securely to the breech; abrasive charged lead bullets are propelled at low velocity via a small charge of Pyrodex ignited by a #11 percussion cap. I have not tried this system enough to evaluate results, and I'm still tinkering about with the load etc... but it looks promising. There's always something new out there - but nothing I can classify as art!!

One final important comment pertaining to lapping - perhaps the most important. If you REAM smooth, uniform diameter holes prior to rifling, lapping will be limited to a polishing operation only - MUCH easier than trying to correct errors in groove diameters! Remember, tight spots in grooves come from loose spots in the bore, which in turn are caused by faulty reaming. Use only the best reamers, plenty of flushing oil, and a uniform feed. Oh yes, maybe you should consider lapping BEFORE rifling. Hmmmm.....

STRESS RELIEVING

There seems to be some confusion among shooters, and even gunsmiths, about stress relief in rifle barrels. Maybe the following will be helpful.

Commercial barrel makers, whether they are using the cut, or the button rifling process, stainless or chrome-moly steel, all get their barrel blanks in the same metallurgical condition. That is, in a heat-treated and tempered state, i.e. hardness R/C 28 to 32, with a tensile strength of around 135,000 to 150,000 PSI. This state of affairs is reached by the usual heat-treat methods.... that is, stated simply, by bringing the steel bars to their critical temperature (1550°F, in the case of 4140 (chrome-moly)), and quenching (usually) in a liquid medium such as oil.

This process leaves the steel in a full hard state, too hard to use for making rifle barrels, not to mention full of stresses. *To relieve these stresses, and to reduce the degree of hardness to an appropriate level,* the steel is then tempered, or "drawn," by reheating to 1000°F (again for 4140 or equal). This lowers the hardness to the 28-32 R/C range that we are looking for.

The secondary effect of this tempering operation is that it relieves residual stresses within the bar. Unless the bar has been subjected to some post heat-treat mechanical trauma such as bending, it is relatively stress free. This is why we can use it as received for making rifle barrels.

If you're a "cut rifle" barrel maker, you're home free. If you button rifle, you're not out of the woods yet. Button rifling, as you know, swages, or cold forms the grooves into the bored and reamed hole. In doing so, compression stresses called "radial" or "hoop" (tensile) stress are introduced into the barrel bar. These stresses radiate in diminishing intensity from the bore toward the outside of the barrel.

Any metal removal from the outside of the bar, such as turning, removes some of these compression stresses from the outer boundary, which, in turn, allows the remaining stresses, less encumbered with the containment of an outer shell, to relieve their force outward. This relaxation of stress outward manifests itself in a larger bore diameter.

If, for instance, a taper is turned from the muzzle to the breech, the resulting bore diameter will be inversely proportional to the turned taper. (In proportion only - not dimensionally). This would be a sad state of affairs but for one other procedure. Button barrel makers stress relieve their barrels a second time - at least the makers of match grade barrels do.

This second stress relief (the first one was by the steel maker) is done by soaking the finished but un-turned blank in an atmosphere controlled furnace at 1000°F or so, which removes most of the residual "hoop" stress. The barrel is then turned to final dimensions, and lapped to specs.

There's a bit of a down side to the second heat relief procedure. By raising the temperature of the barrel to 1000°F, a second "drawing" or further softening of the steel takes place, along with a corresponding loss of tensile strength. This is a result of the tempering process being cumulative.

This extra stress relief is the reason button rifled barrels will be about 8 to 10 points lower in hardness on the Rockwell C scale than cut rifle barrels. It also takes away the argument that button barrels are harder because of the cold working effect.

You might be thinking about a possible advantage in barrel life that you might get with extra hardness, but it's doubtful that you'll gain much. Barrels stop shooting for reasons other than friction wear. I've checked numerous barrels that have lost accuracy (benchrest accuracy), and they all show one common characteristic: a constriction in groove diameter of 0.0003 to 0.0005" approximately 1" ahead of the throat. Although I'm not absolutely certain, I believe this to be a by-product of thermal reticulation (random directional cracks and fissures in the surface of the metal, caused by differential heating and cooling). Sections of a barrel have been examined and some of these fissures appear quite deep, causing the formation of small "platelets". It's quite possible that high pressure at high temperatures penetrates these fissures and forces the "platelets" into the bore, thereby constricting the diameter.

A reminder might be in order about buying barrel steel. It must ALWAYS be made clear to the steel warehouse that you want heat-treated and tempered steel. Ask for a certification that will spell out the analysis as well as the hardness. Never accept anything less than 28 R/C or less than 130,000 PSI tensile. Suitable steel usually has the suffix "H.T." attached to the alloy designation, indicating that it has been heat treated ... e.g. 4140 HT.

a few comments on

DESIGNING AND MAKING RIFLING HEADS

by Guy Lautard

The rifling head is probably going to be the item that scares the average guy off of trying to make his own rifle barrels more than any other single aspect of this whole business. I'd like to offer a couple of thoughts on this, to give you some encouragement.

First, you may be tempted to say to yourself, "Well, I'll make my first barrels in .45 caliber - a rifling head for that size won't be such a watchmaker's job." I think that's the wrong way to look at the matter. Consider instead the possibility of making a .17 caliber barrel, or even a .14. Once you've thought out - just *thought out*, not *made* - a rifling head for a .17 caliber barrel, even a .22 will seem relatively easy, and a 6mm positively luxurious.

Second, how to design the rifling head? My own approach in such matters, where a lotta small parts must be made and fitted into a small space, is to make a big drwg. This approach has the advantage of letting you see all the parts at a large size, the effect of any errors in the drwg are reduced in the actual parts, and by the time you have the drwg done, you've completely built the thing in your head, and you're all psyched up to go into the shop and make it.

Get yourself a good sized piece of paper. If something doesn't come immediately to hand, stop at an art or drafting supply store, or a photocopying shop. There, for a buck or two, you can get all the paper you'll need. A whole roll of tracing paper might not even be a bad idea, as the parts involved tend to be long and thin, rather than square, and a moderate sized roll say 12" wide will provide enough paper for a great many drwgs, plus allowing the overlaying of one piece on another for tracing, without the need for a light table or sticking your drwgs up onto a window.

Another source of paper for drafting jobs of this sort is paper grocery bags. This type of paper is a little dark for easy reading of markings made with a hard sharp pencil, but it has a nice texture for drawing on. Cut the bag open, and flatten it out with an iron on the ironing board. The inside of the front face of a nice quality large brown paper envelope is another good source of suitable paper for drwg on.

The first step in making a drwg of a rifling head is to decide on a scale - and in general, I'd say the bigger the better, within reason. 4 times full size would make good sense for most of the parts. 10x full size may prove even better for some of the smaller pieces, and if your paper size allows it, don't hesitate to go even bigger than that. Once you've decided on the drwg scale, lay down a centerline, and go to work. Make yourself a drwg you can climb right into and walk around in, and when you're done, you'll know everything you want to know about the parts you have to make.

Bill's discussion of the rifling head on the video is pretty thorough, and by watching it several times, and then making a drwg of a rifling head for the size of barrels you want to make, you'll be in good shape.

On the next page you'll find a new version of the rifling head drwg you saw on the video, with a lot more information on it and the 4 pages that follow it - more in fact than you may need, but some of it may save you a little time figuring certain things out for yourself.

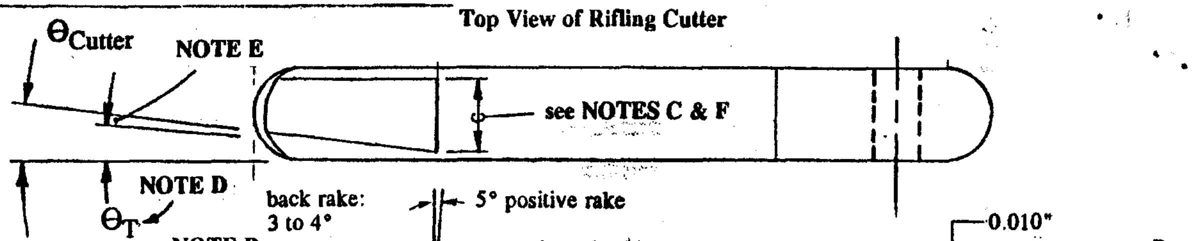
[Incidentally, if you lack, and would like to have, a good drafting outfit, contact me. I have a good source for very fine quality Jacobs rules (a Jacobs rule is a wire guided traveling straightedge) and all the necessary drafting instruments you would need. You may live in an area where you can buy such equipment locally, but if you order from me, I will also send you, at no extra charge, a wad of extra info - an extremely simple way to make an excellent drafting board; better instructions on how to install the Jacobs rule on it than the factory provides; where to get (and properly install) a piece of drafting board surface, and maybe save yourself the price of a good dinner in the process - plus a bunch of drafting info that you will *not* get from a local drafting supply dealer. Just give me a buzz and ask for "the drafting info package". All the drwgs in this Supplement to the Rifling Machine Video were made on exactly the sort of equipment I can get for you, and I won't try to sell you stuff you don't need.]

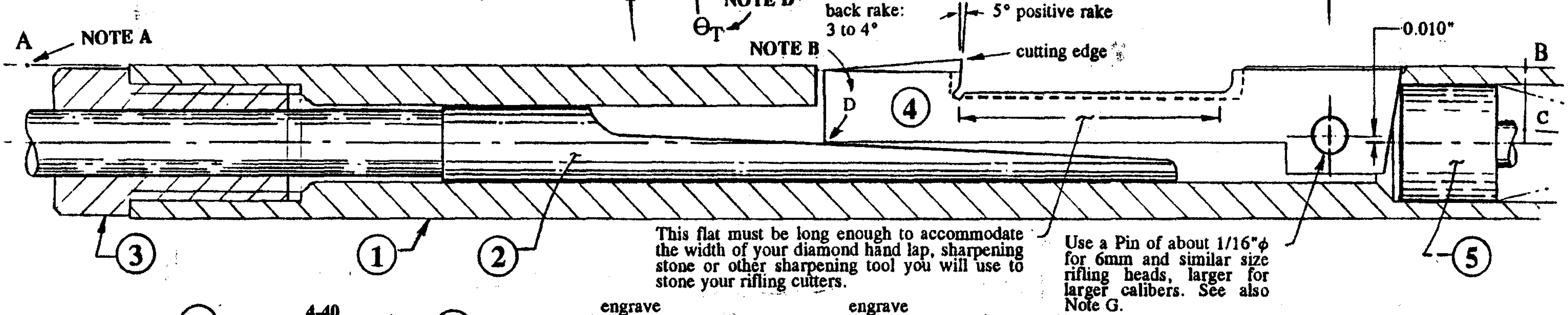
GUY LAUTARD, 2570 Rosebery Avenue, West Vancouver, B.C., CANADA V7V 2Z9
Phone: (604) 922 - 4909

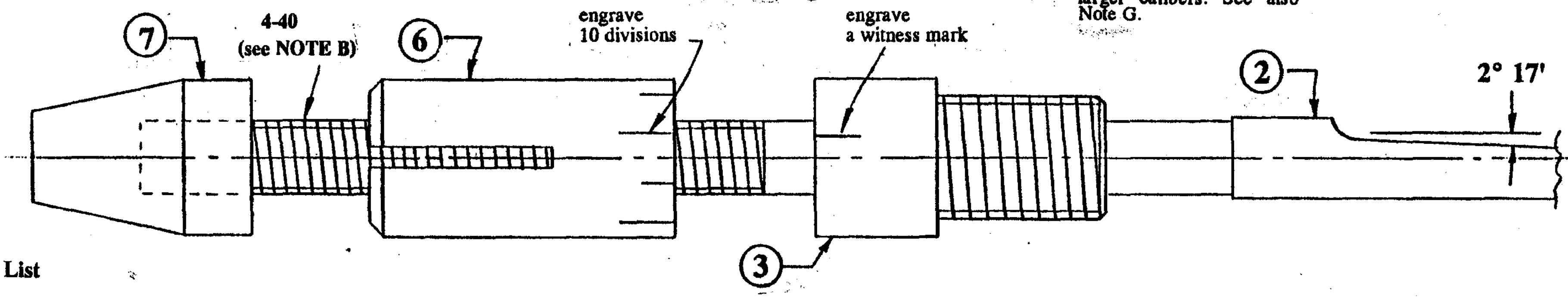
THE RIFLING HEAD - a generalized drawing

NOT TO SCALE GBL Septemeber 11/95

This drawing should be regarded as being only reasonably closely indicative of what you need to make.

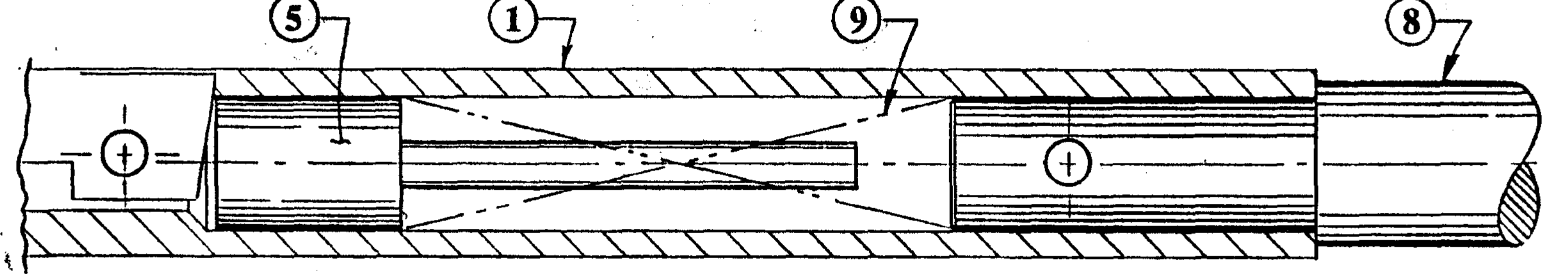




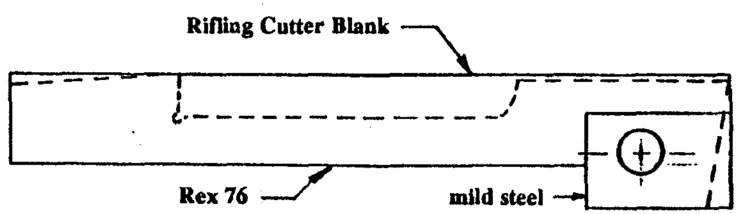


Parts List

1 = Rifling Head Body
2 = Adjusting Ramp
3 = Nut
4 = Rifling Cutter
5 = Plunger
6 = Graduated Ramp Adjusting Nut
7 = Button
8 = Rifling Rod
9 = Spring



NOTE: At the risk of seeming to belabor a point unnecessarily - a mistake some have thought I have succumbed to on other occasions, although they were wrong - I think you will get a lot more out of making an accurate and very detailed large scale drwg of the rifling head you need than you will from trying to make a rifling head from a drwg I might make. You will learn more from your own drwg than you ever will from mine, no matter how good mine might be.GBL



MISCELLANEOUS NOTES ON DESIGNING AND MAKING RIFLING HEADS

NOTE A – If you mark in 2 points A (here) and B 10.1875" to the right along the top line of the Rifling Head drwg, and mark in point C 0.40625" down from B, then points A, B and C then form a right triangle ABC in which angle CAB is 2° 17'.

NOTE B – In designing your Rifling Head, draw the rifling cutter in, in its fully retracted position (unlike what you see here; yes, I'm forcing you to make your own scale drawing!). Then draw in a line parallel to AC and passing through point D on the rifling cutter. This line will be the Ramp surface, inclined at 2° 17' to the Rifling Head's axis. Take it far enough to the left to give you the necessary amount of lift required to cut the rifling to full depth, and more.

Suppose the rifling grooves are to be cut 0.003" deep; then you might want to provide for say 0.007" rise. Divide desired rise by the tangent of 2° 17', thus:

$$0.007" \div 0.039{,}87 = 0.176".$$

This tells you that the Ramp and its attached threaded stem etc. has to be able to give *at least* this much axial movement.

The Ramp is made from 1/8"ϕ drill rod (although it might be larger, if you were making a larger caliber rifling head).

I would buy some 4-40 threaded rod at a hobby store, and tap the Ramp (2) and Button (7) to take same. Although my drwg shows the shank unthreaded where it goes through the Nut, that is not necessary.

NOTE C – RIFLING CUTTER WIDTH: The width of the Rifling Cutter depends on the ratio of groove to land width you want. Bill cuts his grooves about 2.5 to 3 times the width of the lands he leaves between them. To figure land width, use the formula

$$W = \pi D \div (R + 1)n, \text{ where}$$

D = finish reamed bore ϕ
R = groove width compared to land width, and
n = number of grooves.

Say you're making a 6 groove, 6mm barrel; then n = 6, and D = 0.237". And say your groove:land ratio is going to be 2.65:1.

Then $W = \pi D \div (R + 1)(n) = \pi(0.237) \div (2.65 + 1)(6) = 0.7446 \div 21.9 = 0.034"$.

Rifling cutter width will then be 2.65 x 0.034" = 0.090".

Note also that the front face of the Rifling Cutter is drawn as being at 90° to the Rifling Head axis. Bill says you can also make it at 90° to the Helix Angle of the rifling twist. This is not something Bill himself has yet tried - it's simply another area for experiment.GBL

NOTE D – Calculating the Helix Angle of the rifling twist: Let us call the helix angle Θ_T. We use the formula

$$\Theta_T = \tan^{-1} [(\pi D) \div T], \text{ where}$$

D = bore ϕ, and T = rifling twist in inches.

As an example, let's calculate the helix angle for a 6mm bore with a twist of 1 turn in 10":

$\Theta_T = \tan^{-1} [(\pi D \div T)] = \tan^{-1} [(\pi \times 0.237") \div 10]$

$= \tan^{-1} [0.7446 \div 10] = 4.2581° = 4° 15' 29"$, so say **4° 15'**.

NOTE E – The Rifling Cutter also needs about 1-1/2° of helical relief on one side, so it doesn't rub in the groove being cut. You will probably need access to a tool & cutter grinder or a surface grinder to make your rifling cutter, although they can also be made with fine abrasive wheels in a die grinder (or maybe a Dremel Tool), aided by one or two simple fixtures to produce the required geometry.

NOTE F – Here's another place where you could make good use of the concept of making a much larger than full size drawing, if you want to try some form of rifling that is a little out of the ordinary. In my book **The J.M. Pyne stories and other selected writings by Lucian Cary**, at pages 23- 24, the design of Pope's rifling (for cast bullet shooting) is discussed in sufficient detail that you could probably come pretty close to duplicating it. At page 34 in the same book, I show a profile drwg of Pope's rifling. *This book is available directly from me, price: US$26.95.*

NOTE G – To drill the axial holes in the Rifling Head, use well sharpened twist drills and high lathe spindle speed. Mill the cavity for the Rifling Cutter after axial holes are drilled. The cross hole for the Rifling Cutter Hinge Pin must be at 90° to the rifling cutter cavity - I would suggest the use of some kind of roll over fixture (e.g. a V-block that can be rolled over on its side). Note also that this cross hole is not on the centerline of the Rifling Head, but rather is clearly shown to be above said centerline in the Rifling Head drwgs.

Some further notes from Bill re various parts of the Rifling Head:

1. RIFLING HEAD BODY
The Rifling Head Body is 4 - 5" long, and made from oil hardening drill rod. After machining, it is hardened and drawn to approx. Rc 50/55, and ground to a diameter of about 0.000,5" under actual bore diameter. Care is taken to assure that the close fitting 1/8" slot for the cutter (Detail 2) is perpendicular to the hole for the cross pin. The Rifling Head Body should be hardened, otherwise it will become "rifled" after a couple of barrels.

The Rifling Head Body is tapped *("probably 8-40," Bill said when I later asked him by 'phone* GBL*)* in the rear for Detail 3, and reamed in the front for Detail 8. The front, or leading edge of the Head should remain sharp - no chamfer. This discourages the Head from riding over microscopic burrs or refuse, causing irregularities in the depth of cut.

> At a couple of points in the video Bill speaks of "the rifling box," and I think in at least one spot he refers to it as "the cutter box." More often he uses the term "the rifling head." All refer to the same item - the little milled, drilled and tapped slug of drill rod that carries the rifling cutter. GBL

2. CUTTER ADJUSTING RAMP (Make from 0.125"ϕ drill rod.)
We used an angle of 2° 17' on the Ramp, and a 40 TPI thread for the Adjusting Nut (Detail 6). With the OD of the Nut graduated into 10 divisions, this gives an adjustment of 0.000,1" per division. Harden if desired - probably not necessary.

> Bill makes his Ramp and threaded stem in one piece, cutting the thread with a 4-40 die in a die holder on the lathe, thus insuring a pretty accurate thread, even though it isn't screw cut. My own inclination would be to buy some 4-40 threaded rod at a hobby store, and tap both the Ramp and the Button to take same. Bill says that would be doing it the easy way, but concedes that it is not vital that the stem be unthreaded where it passes through the Nut. You'd want to Loctite the redi-rod into the butt end of the Ramp, because when you go to roll the Ramp 180° to raise the rifling cutter for stoning, you don't want the stem to unscrew. Or just make a dedicated habit of always turning the stem "forward" to raise the Ramp, and then continuing on in the same direction to roll the Ramp back down to operating position again. GBL

3. RETAINING NUT
This holds the Adjusting Ramp in place, and is given an index or register mark for the graduations engraved on the Adjusting Nut (Detail 6). Reamed to fit the stem of the Ramp, it does not need to be hardened. Make about 5 thou under Head diameter.

4. RIFLING CUTTER
This is a mean little critter to make. We made it from Crucible's 1/8" square Rex 76, plus 1/8" ground flat stock (GFS). The diagram at the bottom of the sketch shows how we ended up making it, brazing the GFS to the 1/8" square Rex 76 as shown. This allowed a hole to be drilled and reamed for the cross pin. You have to be careful to use a heat sink, though, because if the 1100°F silver soldering temperature reaches what will become the cutting edge, some drawing of the HSS will occur.

> Actually, this union could probably be made just as well with soft solder. Also, although Bill shows the mild steel block set into a right angled cut-out at one end of the 1/8" square HSS tool bit, I would be inclined to simply grind the end of the tool bit off nice and square, butt the cutter bit up to the mild steel piece, and then silver solder them together. I feel that this would be much easier for the average guy to do than grinding out a 90° notch for the mild steel insert. Everybody has their own inclinations in such things. GBL

The actual cutting portion of the Rifling Cutter is ground to the appropriate width, radius and clearance angles for the caliber and twist involved.

We tried making rifling cutters from all kinds of material, including carbide. T-15 (a type of so-called super-high-speed steel) worked well, but was very difficult to grind. (This is as one would expect:- being hard to grind is one of T-15's characteristics. GBL) Once made and in use, T-15 rifling cutters can only be sharpened with diamond laps. "Rex 76" (*) seems to be the best compromise. Fabricated from 1/8" square lathe tool bits, this material is easy to grind, and can be easily sharpened with a fine India stone. The big advantage of using Rex 76 over T-15 is that a fine India stone will be much easier for the average person to come by than a diamond hand lap.

> * In the video, Bill speaks of "Rex AA," "Rex AAA" and "Rex 76." They may or may not be very different one from the other, but they are not the same thing. All are products of Crucible Specialty Metals Division of Colt Industries, Syracuse, NY; "Rex AA" is Crucible's trade name for AISI H26, one of the hot work tungsten type tool steels. See Machinery's H'book for more details. GBL)

The top radius on the Rifling Cutter is ground with the cutter in place in the Rifling Head, which, in turn, is held concentrically in a 4-jaw chuck in the lathe.

The helix angle for a 10" twist in a 6mm bore is about 4° 15'. A clearance of about 1-1/2 to 2° more than this is needed in one side of the cutter to clear the helix of the rifling. Clearance on top of the Rifling Cutter, back of the cutting edge, is about 3 or 4°.

> (This is where the rub lies in making a cutter for what you might not think of as being very hard duty. The rubbing action of the cutter against the top of the groove being cut necessitates the use of pretty good steel. If the cutter dulls from this rubbing (and there's a lot of it, in say 45 passes per groove, even in a 4 groove barrel, that's about 400 linear feet of travel!), you will have to stone the front face back a fair distance to get past the rubbed area, and that may mess up your cutter form. Bill told me he tried various other things like O-6 drill rod, but Rex 76 seems to be about the best choice. GBL)

Finally, the cutter radius is checked using a V-block and indicator; this assures that the cutter radius is concentric with the Rifling Head Body. Any required corrections are made with fine India and Arkansas stones.

Optimum front rake angle varies with different materials and hardness. 5° positive rake is a good starting point.

5. HOLD-DOWN PLUNGER

This is simply a spring-loaded plunger to push the Rifling Cutter into the lowered position when the Adjusting Ramp is retracted for return of the Rifling Head back through the barrel for the next cut. This will be clear from the drwg.

6. ADJUSTING NUT

As the name implies, the Adjusting Nut controls the amount of infeed of the Ramp. With a ramp angle of 2° 17', 1/10 of a full turn of the Adjusting Nut will then give 0.000,1" upfeed on the Rifling Cutter when using a 40 tpi thread on the stem of the Ramp. The Nut is about 5 thou under the Rifling Head diameter. The slitting saw cut shown on the sketch is for adjusting the "drag" of the Nut.

7. CAP NUT

Smaller in diameter and tapered for easy re-entry, the Cap Nut is Loctited or soldered to the rear end of the Adjusting Ramp's threaded stem, and serves as a "handle" for same. Make about 12 thou under Head diameter.

8. PULL ROD

Make from drill rod, in this case 0.218"ϕ turned down to 0.1875"ϕ at the end to fit the Rifling Head. It is held in place by a cross pin, the hole for which is drilled with the Rod and Head held together. It is assembled in the lathe with the Rod in a collet (or chuck) and the Head pushed with the tailstock center, trapping the Spring (Detail 9).

The other end of the Pull Rod is provided with a 3/4"ϕ shank to fit the universal holding block on top of the sled on the rifling machine.

NOTE

The pull tube for the **roughing reamer** can be 0.001" or so under your gun drill size. The pull tube for the **final pass reamer** should be a very close fit to the bore - just a few tenths under the rough ream size, at most - for the first 3" or so next to the reamer. After that first 3", it can be reduced by 3 or 4 thou in diameter for the rest of its length.

9. HOLD DOWN PLUNGER SPRING

We used Remington M700 ejector springs, simply because we had lots of them on hand.

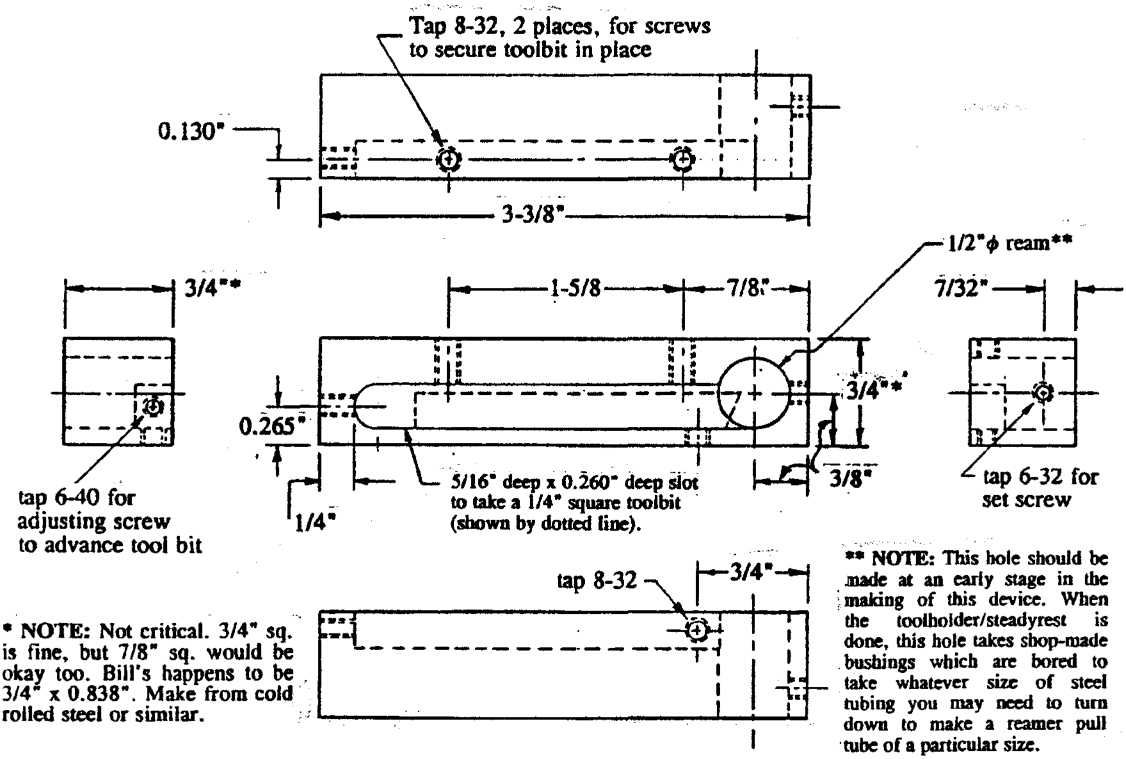
The Rifling Head "title card" from the video is repeated here for your convenience:

THE RIFLING HEAD

rifling head diameter: 0.2365 - 0.2368"
rifling head cutter box mat'l: O-1 or
A-2 steel, hardened to 55/60 Rockwell-C.
rifling cutter mat'l: HSS, silversoldered to mild steel
rifling cutter raising ramp: O-1, 50/55 Rockwell-C.

A COMBINED TOOLHOLDER and TRAVELING STEADY

for turning down long pieces of steel tubing to make reamer pull tubes



Before you can ream a drilled barrel, you will need to make a steel tube of a suitable size for the caliber of barrel you are making. This pull tube, as it is called, is silver soldered to the reamer, and serves as both reamer shank and oil delivery tube. Now obviously turning down a 30" length of 1/4" OD steel tubing to say 0.230"ϕ is not a job one would normally relish having to tackle.... However, the tool shown above makes it easy, and is simple to make.

The device mounts in the lathe toolpost, carries its own toolbit, and acts as a travelling steady. Make a bushing with about 1 thou clearance on the particular piece of tubing you have to turn down to size. Once you get the bushing made, and bfore you go any further, check that it will slide nicely along the full length of your piece of tubing.

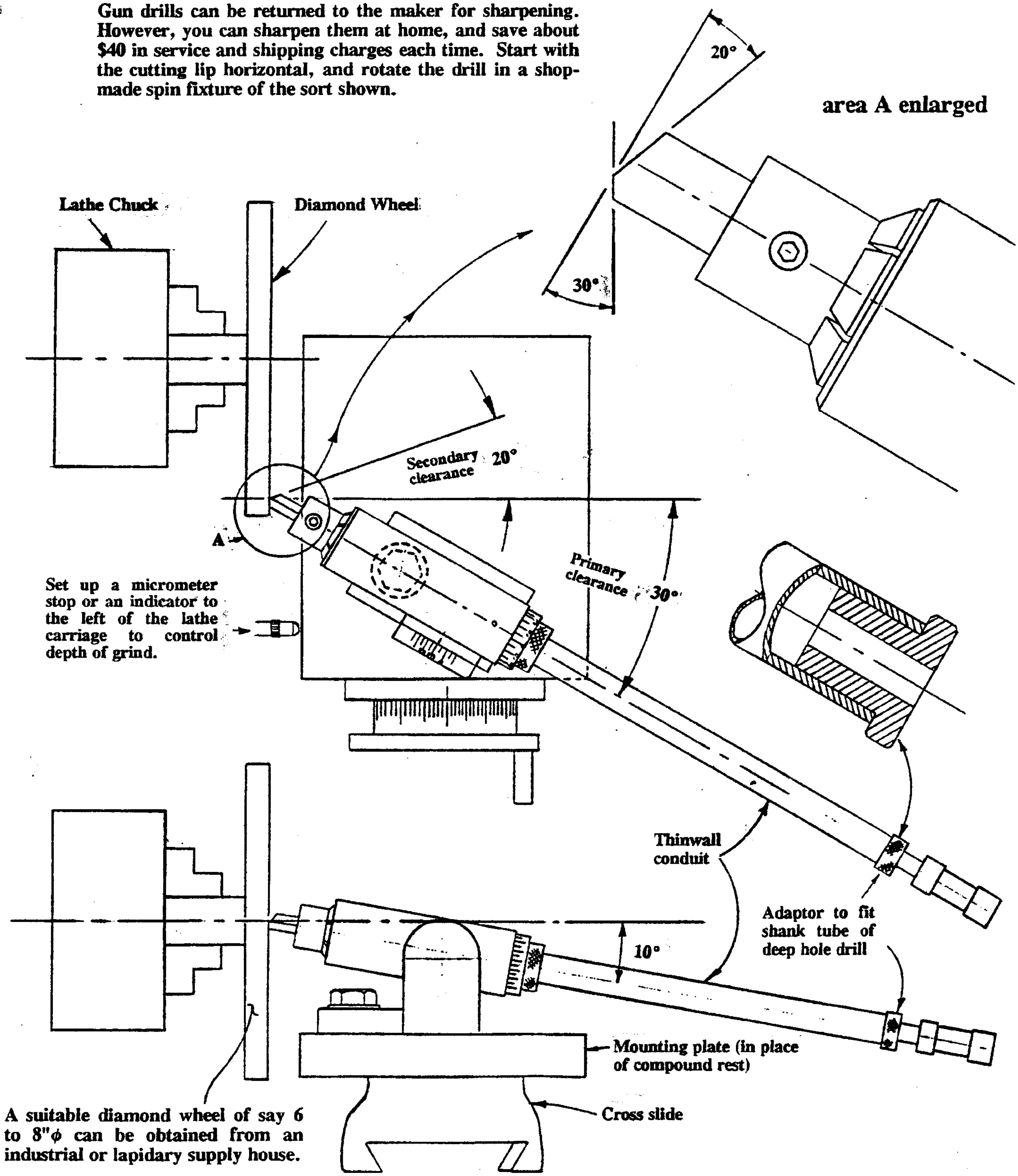
This device steadies the tubing, while the toolbit within the device cuts it down to the desired size. Set up with bushing on center height of lathe, and leading the toolbit slightly; adjust the toolbit so its cutting point is at exact dead center height on the tube, and set so as to bring the tubing down to the desired size. A little cutting oil wiped onto the tube before you start the machining operation is also a good idea.

Very few of the dimensions shown are critical. You will want to measure a few things about your own lathe/toolpost/toolholding system, and then draw up something similar that will fit your equipment.

As Bill says on the video, he found the idea for this device in *Model Engineer Magazine*, but he does not recall in which issue, or who the author was. I believe the idea is from Alan Mackintosh, and if so, the article was in *M.E.* for April 19th, 1974, page 403. Alan Mackintosh is also the designer of the pantograph engraving machine detailed in my book **The Machinist's Second Bedside Reader** (US$21.95), along with a number of other ideas in that book and in **The Machinist's Bedside Reader** ($19.95).

IN-HOUSE GUN DRILL SHARPENING

Gun drills can be returned to the maker for sharpening. However, you can sharpen them at home, and save about $40 in service and shipping charges each time. Start with the cutting lip horizontal, and rotate the drill in a shop-made spin fixture of the sort shown.



these are the various title cards from the video

1.

Bill Webb's Barrel Making Machine
with
Bill Webb and Guy Lautard

filmed on location
at Kansas City, Missouri
May 1995

from Barefoot Video Productions

with special thanks to
Bill and Pat Webb,
Jim Spencer, *and* Connie Grims

2. **Introduction**

3. **OVERALL DESCRIPTION of THE MACHINE**

dimensions: 18" x 75" (approx.)
spindle height from floor: 41"
weight: 500 lbs. (approx.)
motors:
spindle drive: 1 HP, 1725 rpm
oil pump: 3/4 HP, 3450 rpm
drill feed: 1/15th HP gearmotor, 0 --> 50 rpm

time to design & build: 6 weeks
equipment used to build it:
lathe, vertical mill, drill press and hand tools

4. **Phase 1 - Drilling and Reaming the Solid Bar**

5. **Aligning the Chip Box Bushing**

6. **DRILLING**

spindle rpm: 2650
feed rate: 0.5 --> 0.7"/min.
0.000,2 --> 0.000,25"/rev
oil pressure: 600 --> 750 psi
oil temperature:
@ start: ambient, say 60/80°F.
@ finish: 140/160°F.

oil reservoir volume: 10 gallons
time to drill a 28" barrel: 45/60 minutes

7. **REAMING**
spindle rpm: 650
feed rate: 3"/min., or 0.0045"/rev
oil pressure: 150 --> 200 psi
number of passes: 2
hole ϕ
at start: 0.2310"
after 1st pass: 0.2340"
after 2nd pass: 0.2370"

time to ream a 28" barrel: 20 minutes

8. **Phase 2 - Rifling the Reamed Blank**

9. **RIFLING**
number of grooves: 5
depth of grooves: 0.003"
bore ϕ: 0.237"
groove ϕ: 0.243"
number of passes per groove: 35 --> 45

time to rifle a 28" barrel: 2 hours (approx.)

WARNING and DISCLAIMER

Metalworking is an inherently dangerous activity. Both hand- and power-operated tools can inflict serious and/or permanent damage and/or fatal injury. The information in this video and supplementary booklet is provided on an "As Is" basis, without warranty. Warnings re potential dangers associated with procedures described herein are not exhaustive, and cannot cover all eventualities. While every precaution has been taken in the preparation of this material, neither the author, publisher, or distributor shall have any liability to any person or entity with respect to any loss or damage caused or alleged to be caused directly or indirectly by information or instruction contained in this material. It is **YOUR** responsibility to KNOW and USE safe working practices and procedures. If you don't know how to do a job safely, don't try to do it until you find out how to do it safely in your particular shop and shop situation. **Watch out for your own safety at all times. No one else can do this for you**

10. **THE RIFLING HEAD**
rifling head diameter: 0.2365 - 0.2368"
rifling head cutter box mat'l: O-1 or
A-2 steel, hardened to 55/60 Rockwell-C.
rifling cutter mat'l: HSS, silversoldered to mild steel
rifling cutter raising ramp: O-1, 50/55 Rockwell-C.

11. **SOURCES OF SUPPLY**
bearings: Associated Bearings Inc.
gears: local Boston Gear dealer
valves/fittings: local plumbing supplier

deep hole drills: Danjon Mfg. Inc. (203) 272-7258
1075 S. Main St. // P.O. Box 212
Cheshire, CT 06410-0212.

Good source of gun drills in Canada is United Carbide Engineerin[g] (A. Sarenchuk) 416-236-1025

reamers: Pacific Precision Grinding
P.O. Box 2549
White City, OR 97053

barrel steel: local Ryerson warehouse or similar

Oil pump source: Northern Hydraulics phone 1-800-533-5545
P.O. Box 1499
Burnsville, MN 55337-0499

ADDENDUM

(which is to say, stuff added after
we thought we had it all in the bag!)

OIL PRESSURES FOR DEEP HOLE DRILLING

In the video, Bill Webb speaks of drilling barrel blanks at about 700 psi, and at the end of the video, I comment on the use of much lower pressures by another barrel maker Bill and I met at the Grand American Scheutzenfest. Bill thought it would be well to add a further comment on oil pressures here, as follows:

The volume of fluid (e.g. oil) issuing from an orifice (e.g. the hole in the business end of a gun drill) is governed by and proportional to the size of the orifice and the pressure on the fluid on the upstream side of the orifice. (Other things - particularly the viscosity of the fluid - also enter into the matter, but pressure and orifice size are major factors.)

To increase the flow (if all else remains unchanged), you must increase the pressure, or the size of the orifice. Bigger gun drills have bigger orifices. (Stands to reason, don't it? - a 50 cal. gun drill is going to have a bigger oil outlet hole than a .17 caliber gun drill. More chips to wash out of the hole, too.)

The oil pressure recommended for deep hole drilling drops as the size of the hole goes up. Bigger holes require bigger gun drills, which have bigger oil discharge holes at the business end. Bigger orifices give greater oil flow, or *sufficient* oil flow at *lower* pressures. Where you might use 700/900 psi for drilling a .22 or 6mm barrel blank, you might use 500/700 for a .30 cal. barrel and 300/500 for a 50 cal. barrel.

On request, Danjon Mfg. Co. (maker of gun drills) can supply you with tables giving recommended info on speeds, feeds and oil pressures for gun drilling. However, those recommendations are for commercial work, where high production rates are, if not paramount, then far more important than they are to the individual who wishes to make barrels for his own use. The basement barrelmaker can get by quite happily with lower speeds, feeds, and oil pressures than Danjon recommends.

AND A LITTLE MORE ON FIRE LAPPING

The following outfit offers fire lapping kits and info:

Roger Johnston   phone (510) 450-0420
President
NECO (Nostalgic Enterprises Co.)
P.O. Box 427
Lafayette, CA 94549

NECO's basic Fire Lapping Kit is about $67 at date of writing (September '95). The Company also has a video on borescope views of many different makes and types of barrels. Contact them.